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SOLID WASTE DISPOSAL STUDY, GENESEE COUNTY, MICHIGAN

Denzil L. Robinson, et al

Genesee County Metropolitan Planning Commission
Flint, Michigan

June 1968

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SOLID WASTE DISPOSAL STUDY

Technical Report

Genesee County, Michigan

June 1968

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This report is reproduced as received from the grantee. No editorial or other changes have been made, although a title page, foreword, and abstract of the related demonstration grant project have been added as well as a listing of other reports of solid waste demonstration projects.

Since this is an interim report of progress, the conclusions and recommendations presented should be considered as preliminary in nature, pending completion of the project and final evaluation of findings.

SOLID WASTE DISPOSAL STUDY

Technical Report

Genesee County, Michigan

June 1968

Prepared by Special Service Committee, Genesee County Board of Supervisors, Denzil L. Robinson, T. Ray Johnson, Walter C. Kingsley, Jr., Theodore P. Mansour, and LeRoy Nichols under Grant No. D01-UI-00070.

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Consumer Protection and Environmental Health Service
Environmental Control Administration
Bureau of Solid Waste Management
Cincinnati
1969

PREFACE

An estimated 900 million pounds of wastes in the solid state are produced in the United States every day. What to do with these solid wastes, how to dispose of them without needlessly endangering public health and welfare, and how to recover and reuse valuable materials now "thrown away" are among the most challenging and perplexing of current national problems. Because of lack of suitable planning, interest, and public understanding, these problems have reached such proportions that nationwide attention is demanded and action for the development of adequate solutions must be taken.

Intensified action concerning these problems was made possible by the Solid Waste Disposal Act, Title II of Public Law 89-272, which was signed by the President on October 20, 1965. This legislation directs the Secretary of the Department of Health, Education, and Welfare to initiate, encourage, and support a national program aimed at discovering and evaluating better methods of coping with the solid waste problem.

The Secretary is authorized (1) to conduct and support research on the nature and scope of the problem, on methods of more safely and efficiently collecting and disposing of solid wastes, and on techniques for recovering from solid wastes potentially valuable materials and energy; (2) to provide training and financial and technical assistance to local and State agencies and other organizations in the planning, development, and conduct of solid waste management programs; (3) to encourage and support projects that may demonstrate new and improved methods of solid waste collection, handling, and disposal. The Bureau of Solid Waste Management carries out these responsibilities.

Among these responsibilities, the Bureau provides grant support for demonstrations relating to the development and application of new and improved methods of solid waste collection, storage, processing, and ultimate disposal; and grants for studies and investigations that may lead to a demonstration of improved disposal practices, or may provide solutions for regional or national solid waste disposal problems. Associated with this is the responsibility for collecting and making available by appropriate means the results of, and other information pertaining to, such federally supported demonstrations, studies,and investigations.

Accordingly this report has been reproduced to disseminate as widely as possible the latest available information and findings of a project that has received grant support from the Bureau of Solid Waste Management. It is felt that the principal merits of this report are a detailed analysis of (a) alternative methods of solid waste disposal in the county, and (b) the functions of a county agency in implementing a program for the disposal of solid wastes in the county. We hope that this report will provide those working in the solid waste management field with useful information that will be of assistance in developing approaches to the solutions of their solid waste disposal problems.

This is an interim report of project progress, and additional work is currently underway to complete the project. Additional progress reports will be made available by the Bureau of Solid Waste Management. The final report will be issued as a Public Health Service publication.

--RICHARD D. VAUGHAN, *Director*
Bureau of Solid Waste Management

ABSTRACT OF STUDY AND INVESTIGATION GRANT NO. D01-UI-00070

TITLE: Solid wastes disposal study for Flint and Genesee County Metropolitan Area, Michigan

GRANTEE: Genesee County, Michigan
511 Courthouse
Flint, Michigan 48502

PROJECT DIRECTOR: Anthony Ragnone
Genesee County Drain Commissioner
932 Beach Street
Flint, Michigan 48502

PROJECT STARTED: August 1, 1967 **PROJECT ENDS**: July 31, 1968

OBJECTIVE: To conduct a thorough solid waste disposal study for the Flint and Genesee County Metropolitan Area, and recommend an area-wide disposal system.

PROCEDURES: The firm of Consoer, Townsend and Associates in Michigan will provide consulting engineering services.

Data pertaining to existing solid waste collection and disposal practices and quantities and types of solid wastes generated in the metropolitan area will be developed from existing information. Field surveys will be conducted as needed to supplement existing data. Present solid waste disposal needs and projected needs to 1995 will be determined. Recommendations for an area-wide disposal system will be developed.

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GENESEE COUNTY

SOLID WASTE DISPOSAL STUDY

TECHNICAL REPORT

SPECIAL SERVICE COMMITTEE

GENESEE COUNTY BOARD OF SUPERVISORS

Denzil L. Robinson, Chairman

T. Ray Johnson
Walter C. Kingsley, Jr.
Theodore P. Mansour
LeRoy Nichols

"This solid waste disposal demonstration project was supported in part by a grant from the Public Health Service, Department of Health, Education and Welfare".

Department of Health, Education and Welfare
Grant No. 1-DO1-SW-00070 1

CONSOER, TOWNSEND & ASSOCIATES IN MICHIGAN

CONSULTING ENGINEERS

PREFACE

The story of ancient civilization has been traced through investigation of middens and other waste depository of humanity. These ancients could afford the "luxury" of piling their refuse, since land was always available and the community could move to cleaner areas. Then again, it may have been possible to permit natural processes to reduce the offensive nature of refuse piles. However, the population increase in our urban areas has resulted in the disposal of solid waste as a major problem. This problem has grown to the extent that some of our scholars are concerned that we may be inundated in the ever increasing volume of solid waste. We cannot afford middens in our urban areas. If we are to continue enjoying the abundance provided by modern technology, it has become evident that solutions must be provided for the safe, healthful, and efficient disposal of solid waste in our urban area.

Fortunately for this county, enlightened leadership from industry and government early became cognizant of the need to develop solutions to the ever growing problem. The leadership provided by the Manufacturers Association of Flint, the City of Flint, and the Genesee County Board of Supervisors resulted in a decision to proceed on a study to assess the magnitude of the solid waste problem here in Genesee County. Our discussions with concerned people led to an early conclusion that such a study must be conducted for all of the county, rather than for a segment. Consequently, the Genesee County Board of Supervisors assigned the responsibility for implementation of the study to the Special Service Committee and requested staff assistance from the Genesee County Metropolitan Planning Commission.

Discussions with representatives of the Manufacturers Association and the City of Flint resulted in a decision to proceed with a study employing consulting engineers. This discussion also led to an agreement for a cooperative effort and a dicision to solicit assistance of the United States Department of Health, Education, and Welfare. In order to administer this program, the Special Service Committee appointed a Subcommittee consisting of Mr. Thomas H. Haga, Director-Coordinator, Genesee County Metropolitan Planning Commission, as chairman; Mr. Anthony W. DeBlaise, Director of Department of Public Works, City of Flint; and Mr. Ralph D. Whittier, Director of Production Engineering, A. C. Spark Plug Division, representing the Flint Manufacturers Association. Mr. Whittier was subsequently succeeded by Mr. Robert Campbell, General Works Engineer, Buick Motor Division. This Subcommittee solicited proposals from various consulting engineers, recommended the selection of Consoer, Townsend and Associates of Chicago, Illinois, and subsequently administered the completion of the study by our consultants. The Special Service Committee extends its sincerest appreciation for the efforts of this Subcommittee in bringing this study to its successful conclusion.

The Committee also expresses its appreciation to the United States Department of Health, Education, and Welfare and the Genesee County Metropolitan Planning Commission for their assistance, and wishes to note the special contribution of Mr. Fred B. Kellow, Chief, Environmental Health Planning Unit, Division of Engineering, Michigan Department of Public Health. Of course, a study of this nature, affecting a total metropolitan area, could not have been successfully completed had it not been for the wholehearted cooperation in both time and effort on the part of the Flint Manufacturers Association and the City of Flint. Lastly, the Committee would like to recognize all 32 units of government in Genesee County which cooperated with the staff of the Genesee County Metropolitan Planning Commission in the development of this study.

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A C Spark Plug Division, General Motors Corporation
Manufacturers Association of Flint

*Former Member

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SUMMARY AND RECOMMENDATIONS

Genesee County is a region in transition. From a largely farming area surrounding a central industrial city, it is becoming a major metropolitan complex, with more than three-quarters of its people living in urban or suburban surroundings. In the last census, the farm population was down to less than two percent of the total, and even these derived less than an eighth of their income from the operation of their farms. Along with this evolution have come increases in the total population, and in the level of economic well-being of most of the people. There are now nearly twice as many people in Genesee County as there were in 1940. From 1960 to 1964, bank deposits increased 50 percent, and those in savings and loan associations more than doubled. All these factors have combined to create a serious problem in the disposal of the County's solid wastes. The population growth and economic improvement have both tended to increase the amount of wastes produced. The best available information indicates that for every man, woman and child in the County almost one ton of refuse has to be disposed of every year. With the number of people now living in Genesee County, this amounts to approximately 1250 tons of solid waste that some agency must get rid of every day of the year.

Not only is there a huge quantity to be disposed of, but the more urban conditions of life in the County make it harder to find an acceptable place to get rid of it. In earlier, simpler days, the farmers could not only dispose of their own refuse, but could often help out the City dwellers. As more and more people came to live together (in 1960, Genesee County had an average of 583 people per square mile), it became necessary to regulate refuse disposal in the public interest.

The smoke from one backyard refuse burner on a hundred-acre farm is a very minor nuisance, but one in every backyard in suburbia is quite another matter. Dumping tin cans in a ravine may have been acceptable twenty or thirty years ago, but this method of disposal cannot be tolerated today. Faced with the mounting problem of contamination of dwindling water supplies, and the infestation with rodents and insects brought by open dumps, the State of Michigan has set up regulations to control the disposal of refuse. Strict enforcement of these regulations today would probably close 95 percent of the disposal operations in Genesee County. The problem of what to do with the County's solid wastes has become acute.

It is to this problem that the study reported herein has been directed. In addition to studying the present situation in Genesee County, the Engineers compiled information on refuse collection and disposal practices throughout the country, and investigated the factors which can be expected to influence the problem in the future. These include the extent to which the present trends in population growth and greater proportion of urban living may be expected to continue, and what changes are likely in the amount and kind of refuse produced by households, commercial establishments, industry and other sources. Another factor to be considered for the future is the growing need for land, not only to accommodate the increasing population, but to provide recreational facilities for the even larger numbers living in relatively crowded conditions.

Based upon the best available information, it is estimated that at the present time solid waste is being generated within the County in the following quantities:

Domestic or Residential Refuse	83,038 Tons/Year
Commercial and Institutional Refuse	38,197 Tons/Year
Industrial Solid Wastes	246,949 Tons/Year
Dead and Diseased Trees and Bushes	15,000 Tons/Year
Demolition Wastes	67,500 Tons/Year
Dead Animals	140 Tons/Year
Total Solid Wastes	450,824 Tons/Year

The various waste materials making up the above quantities are estimated to be as follows:

	Tons/Year	Percent
Garbage	31,898	7.08
Paper & Cardboard	91,916	20.39
Plastics, Rubber & Leather	6,718	1.49
Canvas & Rags	13,570	3.01
Lumber & Wood	101,050	22.41
Grass & Clippings	8,987	1.99
Industrial Oils & Thinners	2,575	0.57
Dead Animals	140	0.03
Cans, Bands & Wire	20,927	4.64
Glass	15,046	3.34
Ashes	70,474	15.63
Pavement & Concrete	15,115	3.35
Dirt, Sand, Plaster, Etc.	20,814	4.62
Industrial Slurries & Sludges	51,512	11.43
Miscellaneous Industrial Wastes	81	0.02

All authorities agree that both the population of the County, and the amount of refuse produced per capita, may be expected to increase in the future. There is some disagreement about the amount of the increase, but the Engineers selected the following figures as, in their judgment, the most probable:

	1985	1995
Population of Genesee County	655,000	820,000
Total Refuse, lb/capita/day	6.37	6.89
Total Refuse, tons/day	2.087	2,826

In all of Genesee County, only in the City of Flint and two small villages is a part of this refuse collected by an agency of the local government. In all other cases it is either left to the individual or handled by a private individual or company. These operate under agreements with the individual householders, or under a contract with the local government.

Although collection and disposal are simply the two sides of the coin of refuse management, the operating problems are quite different, so they have been considered separately. Disposal is simply the problem of getting rid of the stuff in the safest, most sanitary and least costly and disfiguring way possible. Except for a slight effect on the composition of the refuse, differences between neighboring communities have little influence on the problem of disposal. They may have an overwhelming effect on collection. Take, for example, the number of people per square mile. It can be shown that the approximate average travel time between stops is inversely proportional to the square-root of the average population per square mile. In Genesee County, the townships vary from less than 60 to nearly 2,200 people to the square mile. This means that the time to get from one pick-up point to another in the sparsely populated township will average more than six times as much as in the densely populated one. This can be a significant factor in the total cost of collection per ton, or per household.

Point of pick-up is another thing that affects the time spent per household. To pick up refuse from the side or backyard of a house may take nearly twice as long as picking up refuse which has been deposited at the curb. Frequency of pick-up, also, affects costs. It is obviously cheaper to pick up a week's generation of refuse in one collection than to divide it between two. Yet, commercial establishments and other large refuse producers may be unable to store a week's refuse awaiting collection.

These and other variations are being successfully dealt with by the combination of municipal authorities and private contractors now collecting refuse in Genesee County. There is no manifest reason for an immediate change in the system, and there are several reasons against such a move. A County-wide authority would be far less able to cope with the variations between communities than the present system. Furthermore, when private industry is providing adequate service, to set up a new agency under the sponsorship of a governmental body smacks of bureaucratic antagonism to individual initiative. Also, for every private contractor who goes out of business as a result of this competition, the governments involved face a loss in taxes which should be figured as part of the cost for the new operation.

For all these reasons, the Engineers feel that it would be unwise to disturb the present collection system. This situation may, of course, change in the future, so this recommendation should be periodically re-evaluated. Nevertheless, in spite of the differences between communities, some aspects of refuse collection lend themselves to a certain amount of standardization.

There are many advantages in the standardization in the size of refuse container. Of late there has been introduced both paper and flexible plastic bags for containing residential mixed refuse. Normally the plastic bags are contained within either a metal or heavy plastic container, commonly referred to as a GI can, between the times of collections. On collection days the plastic bag is removed from the container, tied and carried to the curb for pick-up by the collection forces. The heavy paper bags are used for both storage and pick-up without placement in the metal or plastic GI can between pick-ups. The Engineers' recommendation for containers of either metal or heavy plastic, 30 to 32 gallon capacity, can be modified in the future as the paper or plastic bags prove completely satisfactory. However, for the present, it is the Engineers' opinion the metal or plastic GI can is the most serviceable and satisfactory method for storage of residential mixed refuse.

Collection trucks handling mixed refuse should be both as efficient and sanitary as it is possible to make them. The collection trucks picking up mixed refuse should be enclosed to prevent refuse from being spilled or blown away. Until a better method is produced, the compactor trucks have proved the most efficient method of collection equipment for mixed refuse. The trend in collector compactor trucks appears to be standardizing around a capacity of 20 to 25 yards. For these reasons the Engineers recommend use of the compactor truck for all mixed refuse.

As has already been pointed out, disposal problems, unlike those involved in collection, are much the same throughout the County. With the exception of the City of Flint's sanitary landfills, none of the other disposal operations within the County conform in a substantial degree to the requirements of the Michigan Department of Public Health's regulations. To up-grade these operations to the point where they will be in full compliance will result in an increase in cost which must be borne by the users of the service. In the Engineers' opinion, this increase can be kept to a minimum by placing disposal for the entire County under one authority. This can be accomplished by the creation of a "county agency" in accordance with the provisions of Act 342 of the Michigan Public Acts of 1939. Of course, private contractors now disposing of refuse that can comply with the law should have every right to continue. However, interviews with a number of them indicate they would be glad to get out of the disposal end of their business and pass those particular headaches on to someone else.

Composting as a method of disposal has lately been receiving a lot of attention. The idea of making a useful product out of unwanted material is undeniably attractive. Unfortunately, here again, the process employs only a part of the total refuse, and the rest still has to be disposed of by one of the other two methods. Unless each householder, commercial establishment and industrial contributor of solid waste would separate the compostible material from the non-compostible material before collection the cost of sorting after collection becomes excessive. Sorting by the contributor has never proved popular. Composting has been successful in some foreign countries, where the percentage of compostible material in the total refuse collection is much higher than in the United States. Even in the southern parts of this country there are only a few plants which have shown promise, and this is probably due to the longer growing season with the resulting larger amounts of yard rubbish, all of which are compostible. In the northern United States there has, to date, been no wholly successful composting operation. Until the process has shown a record of effective and economical performance under conditions like those in Genesee County, the Engineers believe they would not be justified in recommending it.

Refuse disposal on land can be a satisfactory method of dealing with refuse if certain procedures to prevent nuisances and dangers to the health of the community are scrupulously followed. This is the process known as sanitary landfill. The refuse is deposited in a controlled location, firmly packed down by rolling, and covered at the end of each day with fresh earth. This, in turn, is firmly rolled in place, so each day's refuse is enclosed in a tight cell, completely insulated by a layer of solidly packed earth. Properly run sanitary landfill operations have been conducted in residential neighborhoods without complaint. The outstanding disadvantage in the sanitary landfill method is that it requires a great deal of land.

To reduce the amount of land required for sanitary landfill operations, experimentation has been going on to determine methods of obtaining better compaction. Compaction equipment is now being utilized in many sanitary landfill operations to increase the compaction percentage above that obtainable with the normal bulldozer used in the operation. This, of course, reduces the amount of land required by the sanitary landfill method of disposal. Grinding of the mixed refuse also appears to offer a satisfactory means of reducing the volume or of increasing the density of the refuse in the landfill. The large amounts of tree wastes due in part to the prevalent Dutch Elm disease creates a difficult problem in a landfill operation. Equipment is now available in wood hoggers that will reduce the space required for the disposal of this waste into a sanitary landfill operation. Demolition lumber is similar to the tree wastes, it too can be hogged to reduce the amount of land required for its disposal.

Compaction of mixed refuse by mechanical means prior to depositing the compacted material in the landfill has only recently been in the experimental stage. No adequate data or record of performance is available to give consideration to this method of reducing the quantity of land required for disposal. Suffice it to say that if the experimentation proves successful the cost will, no doubt, be comparable to that required by the mechanical means of grinding as discussed above.

Burning as a method of reducing the volume of refuse and, consequently, the amount of land needed to dispose of it has probably been practiced since the discovery of fire. The method of burning presently used in the Flint area, commonly referred to as the "teepee" burner, has been employed to confine the refuse while it is being burned, but little or no effort is made to eliminate air pollution or obtain a good burn-out. Incineration, which comes from a Greek word meaning "burning to ashes," is a comparatively recent development. A modern incinerator plant looks much like any modern power plant, with well-landscaped grounds. Obviously, the incineration process will have no effect on non-combustible matter, but this does not require previous separation. Except for large and bulky objects, non-combustibles simply pass through the furnace and come out at the other end with the rest of the residue. Another advantage is that the high temperature at which the modern incinerator is operated produces a residue which is almost completely inert. On the other hand, an incinerator plant represents a substantial capital investment. Unless land costs are very high, or enough land is difficult to obtain sufficient for a sanitary landfill operation, it is hard to justify this initial expenditure.

To determine a course of action the Engineers could recommend to the County the first step was to analyze the different classifications of solid waste to determine the best methods of disposal. Certain types of wastes should not be disposed of in a sanitary landfill or an incinerator unless prior treatment is provided or other means of disposal are utilized. These wastes and their present annual generation are given below:

Dead Animals	140 Tons
Industrial Wastes that may be flammable and partially combustible	41,800 Tons
Industrial Ashes, Broken Pavement and Concrete	84,300 Tons
Industrial Chemical Wastes that are not inert	284 Tons
Industrial Explosives	1.08 Tons

Dead animals have been disposed of by burial in the ground or in a landfill. However, this is not the best solution to insure against transmission of infection. The only safe method is to cremate the bodies. The small amount of residue left following cremation can be disposed of in a sanitary landfill operation.

The industrial wastes, such as flammable oils and thinners, should not be disposed of in a sanitary landfill. They could be disposed of in an incinerator by utilizing special burners. In addition to these wastes, industrial plants in Genesee County produce a relatively large amount of slurries and sludges containing combustible materials in addition to large percentages of water. These wastes should not be deposited in a sanitary landfill operation nor can they be handled in a mixed refuse incinerator. Therefore, these industrial wastes require special methods of disposal, and since they are produced in a number of plants throughout the County a central disposal facility would be most economical.

The industrial ashes, broken pavement and concrete wastes account for almost 20 percent of the estimated total generation of solid waste. Although ashes are considered as refuse by the Michigan Department of Health, it is the Engineers' opinion that, since this waste is almost completely inert, consideration should be given to use of this material as fill material rather than burden a sanitary landfill operation with it.

Certain industrial chemical wastes, in addition to the slurries and sludges previously discussed, are not acceptable for disposal as long as these wastes contain active chemicals and are not inert. Since generation of these wastes is limited to only one or two plants, the responsibility of neutralizing such wastes before acceptance for disposal should be with the plants in which they are produced.

The extremely small percentage of industrial explosive wastes should not be disposed of in either a sanitary landfill or an incinerator. This waste should be disposed of by the plant that produces the waste without burden to the County.

Studies were made of the best methods of disposal for the various classifications of solid wastes, including those special wastes discussed above. Preliminary designs were made for the disposal facilities for the first three special wastes as well as for all of the other classifications of solid wastes.

The Engineers estimated the costs of disposal for those three special wastes. Estimates of sanitary landfill methods of disposal were also made based on the assumption that all other solid waste generated in the County acceptable to a County disposal agency would be disposed of as follows:

(a) Utilizing only two disposal sites in the County with minimum compaction percentage, and with specialized mobile compaction equipment to reduce land requirements.

(b) Utilizing four disposal sites in the County with minimum compaction percentage, and with specialized mobile compaction equipment to reduce land requirements.

(c) Using two disposal sites and grinding all mixed refuse as well as hogging all tree refuse and demolition wastes prior to deposition in the landfill - (1) utilizing only bulldozers as compaction equipment, and (2) utilizing the specialized mobile compaction equipment to further reduce land requirements.

(d) Using four disposal sites with grinding equipment at each site and hogging equipment for tree refuse and demolition material at two of the four disposal sites - (1) utilizing only the bulldozers as compaction equipment, and (2) using specialized mobile compaction equipment to further reduce land requirements.

An estimate was made for disposal by incineration of all mixed refuse and hogged tree wastes and demolition wastes with a sanitary landfill disposal operation. The estimated cost per ton for disposal of the various methods of disposal are on the following page:

ESTIMATED COSTS OF DISPOSAL

I. SPECIAL WASTES

Description	Type of Operation	Cost Per Ton
Dead Animals	Special Pathological Incinerator	$295.00
Industrial Oils, Thinners & Combustible Slurries & Sludges	Special Destructor	5.70
Industrial Ashes, Pavement & Concrete	Landfill	0.95

II. ALL OTHER SOLID WASTES

Type of Operation	No. of Disposal Sites	Conditioning Before Disposal	Compaction	Cost Per Ton
Sanitary Landfill	2	None	Minimum	$2.60
Sanitary Landfill	2	Grinding	Minimum	3.36
Sanitary Landfill	2	None	Maximum	2.97
Sanitary Landfill	2	Grinding	Maximum	3.73
Sanitary Landfill	4	None	Minimum	3.35
Sanitary Landfill	4	Grinding	Minimum	4.61
Sanitary Landfill	4	None	Maximum	3.98
Sanitary Landfill	4	Grinding	Maximum	5.24
Incineration followed by Sanitary Landfill	2	-	Maximum	9.47

Based upon the studies of (1) the present collection and disposal of solid wastes within Genesee County, (2) the limited life of existing disposal facilities, (3) the present and estimated future generation of solid wastes, (4) the availability of suitable land for disposal, (5) the various methods of disposal that were studied, and (6) the estimated costs for disposal of the different methods, the Engineers make the following recommendations:

1. The Board of Supervisors of Genesee County should create a "county agency" to dispose of all acceptable solid wastes generated within the County as soon as possible. The Engineers recognize that it is impossible to immediately put the County into the refuse disposal business; however, since the availability of existing disposal facilities both by the City of Flint and the private contractors have such a limited life, steps should immediately be taken by the County in the creation of such an agency. Authority is contained in Act 342 of the Michigan Public Acts of 1939. Such an agency could be operated by either the County Road Commissioners or the Drain Commissioner, as determined by resolution of the Board of Supervisors.

2. Following immediately after the creation of the County Agency to provide disposal facilities for the County's solid waste, the Agency should enter into contracts with the various governmental units within the County for the disposal of the solid wastes generated within such governmental units. The County Agency should agree to accept all domestic, commercial and institutional mixed refuse as well as the

acceptable solid wastes generated by industry within the County. In order to establish the costs for performing the service of disposal the County Agency should have prepared complete plans, specifications and estimates of construction and operating costs of the proposed facilities so that rates, charges and/or assessments to be imposed or collected for each specific disposal service may be established.

3. Based upon the contracts entered into with the other governmental units within the County, bonds should be issued to provide funds to purchase the necessary land, the disposal facilities as required by the detailed plans and specifications for the construction and equipment, and such other funds as may be required. Such bonds could be issued for a period of not more than forty (40) years. However, the Engineers have based amortization costs in the preliminary estimates of costs on a twenty (20) year issue for land and structures, with ten (10) years for land improvements and five (5) years for mobile equipment and building furnishings and equipment. If longer-term bonds were issued especially for mobile equipment, a sinking fund or depreciation amount would have to be established in the rate structure to provide funds for purchase of replacement mobile equipment during the life of the bond issue. This would probably result in the same cost, but it could also result in a higher cost on a per-ton basis than that used in these preliminary estimates. Bonds for such an improvement could be issued backed by the full faith and credit of the County, or by the full faith and credit of the contracting governmental units. Revenue bonds could also be issued backed by the

revenues from the disposal facilities. It is the opinion of the Engineers that a revenue issued should not be utilized unless there are other restrictions to the issue by the County of general obligation bonds, since revenue bonds would, no doubt, require a higher interest rate than general obligation bonds.

4. The County Agency should not at this time act as a collecting agency, except in the case of dead animal collection outside the city limits of Flint, even though the act permits the "county agency" to also perform this service. In the event that present collection facilities fail in the future to provide adequate services, the County Agency could at that time enter this operation in addition to the disposal operation. The cost of the collection of dead animals and the cost of disposal of all dead animals by utilization of the recommended pathological incinerator should be borne by the County.

5. The costs of disposal of dead and diseased trees originating on public land outside the corporate limits of cities and villages within the County should also be a charge against the County. Those originating within the corporate limits of cities and villages should have the cost of disposal charged against the city or village in which the waste originated.

6. The costs for disposal of demolition wastes and all acceptable industrial wastes should be charged against the contributor.

7. The County Agency should construct and operate disposal facilities as follows:

(a) A pathological incinerator for animal cremation.

(b) A liquid and sludge destructor to dispose of industrial oils, thinners and slurries and sludges containing combustible material.

(c) Land and facilities for disposal of industrial ashes, broken pavement and concrete.

(d) Sanitary landfills at two locations within the County, one to the northeast and one to the southwest of the City of Flint. Consideration will have to be given prior to 1985 to expanding the operation to two additional disposal sites, one to the northwest and one to the southeast of Flint, unless better compaction equipment becomes available in the near future at a reasonable cost that could lengthen the life of each of these sites.

8. Plans should be prepared for the ultimate use of the filled land as County parks and recreation centers. The preparation of such plans prior to completion of filling a particular site or area would facilitate completion of the landfilling operation to provide the ground contours needed for the parks and recreational areas. Such plans could result in filling the land to much higher elevations than contemplated in this study and thus increase the capacity of the land to accommodate more tonnage of solid wastes, and thus reduce land requirements. Since at the inception of the County Agency plan of operation purchasing rather large tracts of land are contemplated, the unused acreage could be either rented for farming or loaned or rented to another agency of the County for use as parks for recreation until such time as it would be required for the landfill operation.

9. Although a "county agency" for collection of all solid wastes generated within the County is not recommended at this time, there are certain items that have come to the attention of the Engineers during the study that should be given consideration by the governmental units that have control over the collection and disposal of refuse within their corporate limits. These are as follows:

(a) Standardization of containers for domestic mixed refuse collected by a public agency or where contracts exist between public bodies and private contractors - 30 to 32 gallon containers constructed of either galvanized metal or plastic material, equipped with suitable handles and a tight-fitting lid, are recommended.

(b) Each household should be permitted a maximum of four such containers, with a filled weight not to exceed 75 pounds per container, for once-a-week collection, and all refuse except tree and brush trimmings should be placed in these containers.

(c) Tree and brush trimmings should be tied into bundles of not over 50 pounds each nor longer than 4 feet.

(d) Those municipalities and townships not presently having a public collecting agency nor a contract with a private collector should consider passing such an ordinance to provide a uniform service to the residents at the lowest possible cost.

(e) All public and private collectors picking up mixed refuse containing putrescible matter should be required to use drip-proof, enclosed collector trucks, preferably of the compactor type.

(f) Open burning of all types of refuse should be prohibited.

The City of Flint is presently the only governmental unit within the County that operates both a collection service and a disposal service. The two sanitary landfill sites now being used by the City have about six years of life expectancy. Under the provisions of Act 342, the County could acquire these sites and operate them under the County Agency if agreeable to the City of Flint. This could be a method for the County Agency to actually start operation of a disposal facility during the time that plans were being prepared, land was being purchased and facilities constructed for the operations as recommended. It would also serve as a training ground for operating personnel that could be the nucleus of manpower for the larger operation.

I. INTRODUCTION

A. COUNTY OF GENESEE

1. Geographic

Genesee County is situated in the southeast portion of the southern peninsula of Michigan. It covers an area of 642 square miles, lying between 42°47' and 43°12' north latitude, and between 83°23' and 83°57' west longitude. Its maximum dimensions are approximately thirty miles north to south, and twenty-four miles in an east-west direction. The northern boundary of the county lies about twenty-four and one-half miles south of the southernmost point of Saginaw Bay, and the eastern boundary roughly fifty and one-half miles west of the St. Clair River where it flows out of Lake Huron.

Genesee County has a moderate climate, typical of the lower Great Lakes region, with a mean annual temperature of about 47 F. It is essentially a continental climate, somewhat modified by the influence of the lakes, which nearly surround the southern peninsula. The sixty-seven-year maximum temperature in Flint, the county seat, was 108 F, while the lowest recorded during the same period was 28 F below zero.

Genesee County is relatively densely populated, the 1960 Federal census showing a total population of 374,313, giving an average of 583 people per square mile. This is exceeded, in the state of Michigan, only by the counties which make up the Detroit metropolitan area. Flint is the major city, as well as the county seat, embracing more than half of the county population within its boundaries. It is located almost exactly in the geographical center of the county, and is the hub of a metropolitan area. It is surrounded by a constellation of smaller cities and villages, of which the largest is Fenton, with a 1960 population of 6,142.

The City of Flint had a population, according to the 1960 census, of 196,940; 23,931 were listed as living in the other cities of the county, and 5,976 in the villages, leaving 147,466 living in the surrounding country. With the increasing urbanization of the surrounding countryside, Flint's share of the county population has been steadily decreasing over the last twenty years or more, but its importance as a commercial and industrial center has been increasing. As the focus of the county, Flint is served by two airlines, at an up-to-date municipal airport, two major trunk-line railroads, three interstate bus-line companies, one local bus transportation authority, forty-five common carriers and trucking lines, one newspaper, seven radio stations, and two television stations.

The county is located almost entirely in the drainage basin of the Flint River. A small section along the northern border is drained by the Cass River, and the drainage of the southwestern part flows into the Shiawassee. These three rivers, together with the Tittabawassee, combine to form the Saginaw, which empties into Saginaw Bay, an arm of Lake Huron.

2. Geological

Genesee County occupies a part of the Michigan Basin, which rests on a series of sedimentary rock formations laid down when this part of the country was covered by a vast, relatively shallow, inland sea. These deposits were cemented and compressed by the weight of succeeding layers laid down throughout the Paleozoic Era. Two distinct systems form the bed-rock of Genesee County, both being the products of the Carboniferous Period toward the end of the Paleozoic Era. The northwestern half of the county rests upon Saginaw Limestone of the Pennsylvanian Epoch, while the remainder is underlain by rocks of the Mississippian Epoch, mostly Michigan Sandstone, but with areas of Napoleon-Marshall Sandstone in the far eastern and southern portions.

The inland sea under which these rocks were deposited was at times quite fresh, while at other times it was supersaturated with salts, which precipitated and formed thick layers on the bottom. These still persist in certain areas as layers of evaporites, such as rock salt or gypsum, imbedded mainly in the Mississippian strata. The mineralized waters impregnate the shales, limestones, sandstones, and dolomites to this day, except where fresh water from rainfall or melting snow has replaced them and leached out the salts.

At some time near the end of the Paleozoic Era, this area became dry land, and erosion set in. Stream beds were carved in the rock, and soil was formed which, under favorable climatic conditions, supported luxurious vegetation and abundant animal life. The surface geology as it appears today, however, was largely formed by the great Pleistocene ice-sheet which covered the whole northern part of North America. The topography which we see today is very largely just as it was left by the final retreat of the ice-sheet after the Wisconsin stage.

Where the front of the ice-sheet paused in its retreat, the melt rate just equalling the speed at which the mass of ice advanced over the ground, great quantities of debris were deposited along the melting face. This formed terminal moraines which can still be identified. The Flint Moraine, for example, passes through the central part of the City of Flint and extends to the northeast and southwest beyond the borders of the county. It is roughly paralleled by the Fowler Moraine, which passes through the City of Grand Blanc. At periods when the outthrust of the huge mass of ice was insufficient to overcome the friction of the surface over which it moved, the ice became stagnant, and melted down from the top. This formed what are known as till plains, or ground moraines. These generally consist of relatively fine heterogeneous or unsorted glacial debris, and are found, in Genesee County, north and west of the Flint Moraine, and on either side of the Fowler Moraine. The immediate flood plain of the Flint River, and the entire northwest corner of the county was formerly either lake bed or spillway, and is characterized by deposits of clay or loam.

The natural drainage of much of this area is poor, and farmers have had to resort to artificial methods to render the land sufficiently dry to be tillable. Although there are some sorted deposits of sand or gravel with high porosity, most of the soil is relatively nonporous, particularly in the marshy areas of the southern portion of the county. This region contains a number of lakes, most of which are found where mineral matter has sealed the interstices of the underlying deposits and reduced the porosity almost to zero. Many depressions throughout the county become temporary lakes during periods of heavy rains and melting snow, draining slowly by percolation into the water-table below. The excess water overflows into the rivers draining the area, causing serious flooding.

It appears obvious from this discussion of the geology of Genesee County that the selection of any area for the disposal of refuse must be made with great care, and only after extensive consultation not only with the State Department of Health, but with the State Geologist as well, to insure against pollution of the critical water resources of the region.

3. Historical

Other than the native Indians, the first settler to establish a home in what is now Genesee County was Jacob Smith, who located on the bank of the Flint River in 1819. In 1830, John Todd brought his family to the area and opened the first store. In 1835, two years before Michigan became a state, the thriving settlement of Flint was made the judicial seat of Genesee County. By 1855, Flint had grown to the point where it was incorporated as a city.

The first business which brought the "palefaces" into this part of the country was the fur trade. The abundant game which inhabited the luxurious forests of Michigan made the hunting and trapping of animals for their pelts a profitable occupation for many years. The fur-traders and trappers were followed by the loggers, attracted by the fine stands of timber which covered a large part of the state. Soon sawmills were erected on most of the rivers, and the manufacture of lumber and wood products began. As the forests were cut down, and the loggers moved on, the trappers, the fur-traders, and the lumberjacks, all basically birds of passage, were replaced by a more stable population. Agriculture took over the land where the stately forests had once stood unchallenged.

This period also saw the beginning of industry. The first factories were small shops concerned only with meeting local needs. In addition to the sawmills, woolen and textile mills, flour mills, cobblers, furniture makers, and wainwrights were soon flourishing. In Flint there was developed the "road cart", a two-wheeled vehicle especially adapted to the rather primitive roads then available. It proved very useful in the pioneer communities of the area, and production expanded rapidly. As new settlers and increasing wealth began to bring some of the comforts of civilization to the frontier, and as roads were improved, there was a demand for more sophisticated types of vehicle, and the factories which had developed the "road cart" added to their lines, until Flint became known as "The Vehicle City". It was said to be the world's largest center of vehicle manufacture, and its products were known throughout the carriage and wagon using world.

When the gasoline-powered vehicle began crowding out the horse, the Flint manufacturers adapted their factories to the manufacture of the "horseless carriage". Their long experience in the making of wheeled vehicles, and the well-established tradition of excellence and leadership stood them in good stead, and Flint quickly occupied a position of importance in the burgeoning automobile industry. Genesee County now ranks second only to the Detroit area among the largest automobile producing regions of the world. Plants of the Buick, Chevrolet, Fisher Body, Ternstedt, and A-C Spark Plug Divisions of the General Motors Corporation are located in the county. There are also plants of many manufacturers supplying the automobile industry, among the largest being E. I. duPont deNemours & Company, and Standard Cotton Products.

4. Economic

Genesee County is largely urban, and primarily industrial. Half of its labor force is employed in manufacturing, as against the state average of thirty-eight percent. Its median educational level is equal to that of the state as a whole. The median income is somewhat higher than the state average, but it is concentrated in the middle income bracket, with a substantially lower percentage of very high and very low incomes. In 1964, only two percent of its population were on relief. Genesee County people live mainly in single family dwellings, most of them owner occupied, and predominantly well maintained and well equipped. Bank deposits and savings and loan association accounts are somewhat below the state average, but they are increasing far faster. Manufactures of all kinds are represented in the county, and the major ones paid a total of half a billion dollars in wages in 1963. It is only fair to point out, however, that the economy of the county is closely tied to the automobile industry.

At the present time, the economy is booming. The value added by industry in the county nearly doubled in five years. Total retail sales increased twenty-six percent in the same period, while the population only increased by approximately seventeen percent. Although the land usage trend is toward urbanization throughout the county, half of the land was still in farms in 1964. They are, by and large, relatively small farms, averaging about 115 acres. In 1964, only one farm remained of a thousand acres or more. The total value of the farm products sold in the county was a little over ten million dollars in 1964, but the average per farm was only about six thousand. Nearly all members of farm households derive income from other sources, some fifteen percent working off their farms one hundred days or more during the year.

The general picture given by this brief summary of the economics of Genesee County is of a prosperous, highly urbanized community. Such a community should generate domestic refuse with a relatively low percentage of putrescible food wastes, and a very high percentage of cellulose, in the form of paper and paper products, and of various forms of plastic packaging materials.

5. Refuse Management

Refuse collection and disposal practices have almost invariably lagged behind the needs of a community, and Genesee County is no exception. It is easy to understand why this happens. In the early days of the county, when the population was small and scattered, the disposal of refuse was not even identified as a problem. The individual households took care of their own refuse in various ways: edible waste was usually fed to domestic animals; combustible matter was burned, either in stoves or in the open; incombustibles were dumped, either in ravines, gullies, or other unproductive areas on their own property, or on property in the neighborhood which was considered worthless.

As more and more people began living in towns and villages, however, difficulties arose. Their opportunities to dispose of refuse on their own property were much more limited and, as vacant land was used for building, it became harder and harder to find nearby places to dump it. Farmers in the neighborhood found an opportunity for profit in this situation and contracted with individual householders to pick up their garbage, which they then fed to their hogs. The parties to these agreements found them to their mutual advantage; the town dwellers had their garbage taken care of at no cost to them, and the farmer got free feed for his hogs. Unfortunately for many of the urban residents, these arrangements were individual and subject to no regulation by the community. The farmer was guided only by the profit motive, and naturally preferred to collect his garbage where he could obtain the greatest quantity with the least time spent in pick-up and hauling. This meant, in practice, that the more scattered residents of the towns and villages still had to take care of their own garbage as best they might. And, of course, all of the urban population still bore full responsibility for its rubbish.

In an attempt to meet the problems of residents of the less populous areas, the City of Flint, in 1917, contracted with a private scavenger to collect garbage within the city limits. This brought the collection under the control of the municipal authorities, and routes, as well as frequency of collection, could be specified. The handling of the garbage was primitive, even by the lowest current standards. Garbage was frequently left in uncovered receptacles, and was hauled in open, horse-drawn wagons. Gradually other communities followed Flint's lead, but it was 1954 before some of the smaller outlying towns had any form of systematic garbage collection. Even today, garbage is often simply dumped in ditches along the roads (see Figures IV-9 and IV-11, on pages IV-39 and IV-40).

By 1919, the scavenger who had undertaken to collect garbage for the City of Flint was in financial trouble. Increasing difficulty of disposal, and a decrease in the amount of edible waste available from each household because of the greater use of pre-packaged foods, cut into his profit. The city bought him out, and established its own municipal collection system. Only garbage was collected at this time, and fed to the hogs at the City Farm. The Commissioner who was responsible for collection and disposal derived part of his income from a percentage of the profits of the municipal hog-raising operation. This, as they thought, solved the problem of garbage disposal, for the time being at least.

In 1953, the State of Michigan had adopted an ordinance regulating the feeding of garbage to hogs. A number of epidemics had been traced to pork from hogs fed contaminated garbage, and the ordinance prohibited the feeding of raw garbage to any animal that was to be used for food. The era of cheap swill for hog farmers was over. The cost of cooking all garbage before it could be fed to the animals made this source of food as expensive as commercial prepared feeds, and the farmers lost interest in taking care of the city dweller's garbage. This not only forced the urban communities to expand their collection systems to take care of those whose garbage had formerly been picked up by the hog farmers, but it introduced an acute problem of disposal. Dumps now had to be found for the edible wastes that the hogs had formerly disposed of, and with increasing urbanization this was becoming more and more difficult.

The trend to a reduction in generation of garbage and an increase in the paper and plastic products over the past 15 years resulted in the City of Flint expanding its collection system to include rubbish in 1965. Combined collections have been the rule since then, not only in Flint, but in many smaller communities as well.

Availability of disposal sites for the refuse of the county has been reduced by the increase in suburban population. Both municipal and private contractors now hauling refuse in Genesee County are often confronted with long hauls to find a place where they will be permitted to dispose of what they collect.

B. BACKGROUND OF STUDY

1. Environmental Deterioration

Genesee County has been faced with the same problems that have plagued fast growing communities throughout the nation. What might be described as the "frontier psychology" has delayed any long range planning until the deterioration of the environment has become so noticeable that it is forced to peoples' attention. Until that time, there is, often subconsciously, the feeling that one can always move on to untouched territory.

In Europe, the supply of untouched land has been so small for generations that most European countries have accepted the idea that they must conserve what they have. Old neighborhoods must be kept up, because there are no vast unspoiled stretches people can move to. They have to save what they have in the way of environment, because it is all they have. In this country, particularly west of the Allgehenies, the time when this was true frontier territory is only a few generations back, and it is hard to change our habits of thought.

2. The Need to Reverse the Trend

Genesee County is more fortunate than many places, however, in having a number of forward-looking citizens who have seen the handwriting on the wall. They recognized that the careless waste of our environment must be stopped, and that the trend toward urban blight must be reversed. This realization has resulted in a growing determination to replace the haphazard development of the community with an orderly pattern of growth.

3. Organization

As one major facet of this program, the special problem of solid waste disposal was referred to the Special Services Committee by the Genesee County Board of Supervisors. This committee, in turn, appointed a subcommittee, in which it solicited the active participation of the City of Flint and the Flint Manufacturers Association. The subcommittee's charge was to have an investigation made which would study the present solid waste collection systems, determine the amount and kind of waste that had to be disposed of in the county, now and in the immediate future, and appraise the relative feasibility of the several methods available for dealing with this refuse.

The County of Genesee and the City of Flint entered into contract with Consoer, Townsend and Associates in Michigan, referred to in this report as the Engineers, to serve as consultants on this project. The study has been partly financed by a grant from the Office of Solid Wastes, U.S. Public Health Service, Department of Health, Education and Welfare. The objectives were to conduct a comprehensive study, including an analysis of the waste produced and an inventory of present disposal facilities. The study would also project solid waste disposal needs to 1995 and recommend an efficient collection and disposal system for the Flint metropolitan area and Genesee County.

C. METHOD OF STUDY

1. Previous Studies

As a necessary first step in a study of refuse management in the County of Genesee, the Engineers familiarized themselves with all the available relevant studies previously made. These may be divided into two classes. The first consists of those general studies of the region which are not specifically directed toward the problem of solid waste disposal, but which contain data which have a bearing on it. This group may be still further divided into studies dealing with the geology of the area, and comprehensive studies of land-use, transportation, etc. Among the latter, the massive Comprehensive Master Plan; Flint, Michigan, published in 1960 by the Flint Planning Commission, has proved the move valuable. The prospectus, published in July of 1966, for a Comprehensive Land Use-Transportation Planning Study of Flint and Genesee County, has been reviewed for ideas regarding method, but since it is, in effect, only a "plan for planning," it contains no data relevant to the present study.

Among geologic studies, extensive use was made of the report, Water Resource Conditions and Uses in the Flint River Basin, published in 1956 by the Michigan Water Resources Commission. Much valuable information was also obtained from Ground Water Contamination and Legal Controls in Michigan, Water Resources of the Flint Area, Michigan, and other publications of the United States Department of the Interior.

2. Study of Solid Waste Collection Systems

The City of Flint's Department of Public Works collects all domestic and small commercial establishments' mixed refuse within the City. Private collectors are employed in all other areas of the County to collect mixed refuse from both the residences and business concerns, except in the Village of Otisville and Otter Lake. The private haulers also handle the collections of solid waste from the larger commercial establishments in the City of Flint.

The industrial portion of the County's solid waste is basically collected by private collectors. In some instances, the industry producing a particular classification of solid waste will transport with their own equipment that waste to one of the privately operated disposal sites.

Flint's Department of Public Works has three 9 cubic yard top loading compactor trucks, twenty-three 16 cubic yard rear loading compactor trucks, three 20 cubic yard rear loading compactor trucks, and two 20 cubic yard side loading open trucks. The latter are utilized in making pick-ups of Christmas trees and bulky items, such as discarded furniture, household equipment, etc., that is collected in the annual spring clean-up week usually conducted the first week in May.

For the annual spring clean-up week the City also rents trucks from private haulers.

The private collectors operate compactor type trucks, flat bed stake type trucks, and open dump trucks. Industrial slurries and sludges are picked up in open watertight trucks with dump gates. Information as to the number and sizes of the different types of trucks operated by the private collectors was not made available to the Engineers.

The two small communities previously mentioned, the Village of Otisville and Otter Lake, operate a municipal pick-up service. The collection truck in both instances is of the open type, operated by the municipality during the majority of the week for other work.

Collections from residences in the City of Flint are made once each week with the refuse being picked up at the curb. Collections in the business district from the small commercial establishments are made each day, or less frequent depending upon the magnitude of refuse generated. The City operates two 20 cubic yard compactor type trucks Monday through Friday in this pick-up service.

Frequency of collection by private collectors in the other municipalities in Genesee County and in the townships is generally on a weekly basis. However, if the individual requires more frequent collection, he arranges for such additional collections with the private

er.

Of the eighteen townships within the County, only five have agreements with private collectors for pick-up service within the township. In the remaining thirteen townships the individual arranges for refuse collection and disposal service if he desires this service. Five of the seven cities in the County, not including Flint, have collection agreements with private collectors. The other two, as well as the villages within the County, not previously mentioned, have no governmental agreements with private collectors--each householder makes such agreements as he may desire.

3. Estimation of Generation of Solid Wastes

Only the Department of Public Works in Flint maintains records of their operations as to quantities collected. Estimates of cubic yardage of refuse collected are recorded, and, in addition, all loads collected during the weeks of January 10 through 14, 1966 and July 17 through 22, 1967 were weighed and recorded.

During the study the Flint Department of Public Works conducted sampling surveys on three representative collection routes that were supervised by the Engineers to determine the average analysis of the residential mixed refuse being collected. These sampling surveys were conducted during July, 1967 and January, 1968, and were made on identical days of the week from the same collection routes. All refuse collected from the different routes sampled was weighed and then segregated into the various classifications and re-weighed to determine the various percentages.

The Engineers also conducted sampling surveys of the commercial mixed refuse being picked up by the City of Flint's collection forces and by the private collectors within the City from the larger business concerns.

The Genesee County Metropolitan Planning Commission sent questionnaires to all local governmental units, except the City of Flint, within the County to obtain information and data on the methods utilized in collection and disposal of their solid wastes and estimated quantities. Replies were received from each local governmental unit within the County. However, since private collectors were by and large providing both the collection and disposal service, very little information was available from the local governmental units as to quantities of refuse generated.

In addition to the questionnaires to the local governmental units, the Genesee County Metropolitan Planning Commission also made a sampling survey of the commercial establishments' generation of solid waste in the City of Flint. This was accomplished by sending questionnaires to every tenth listing in the commercial directory of Flint. Approximately 50 per cent replied and the returned questionnaires were turned over to the Engineers for analysis.

The Engineers visited the offices of the various private collectors, as well as the disposal sites where the individual collectors disposed of the refuse collected. Some of the private collectors were quite cooperative in supplying information. However, since no weights or records of cubic yardage were available, the information supplied did not have sufficient reliability to be used in determining the quantities of refuse being generated.

To determine the generation of industrial solid waste, the Industrial Waste and Pollution Control Committee of the Manufacturers Association of Flint made a very complete survey of all industrial refuse contributed by the major industries in the City of Flint and the County. This survey followed a Waste Disposal Survey made in July, 1966 by the Chevrolet Flint Manufacturing Division of General Motors Corporation for their plants in Genesee County.

Along with these specific studies and surveys the Engineers used the general information on the County compiled by the United States Census Bureau, and population projections prepared by other organizations. Helpful information was also obtained from copies of several departmental memoranda made available by the City of Flint. The Engineers also obtained copies of all State, County, or Municipal laws or regulations which might bear on the collection and disposal of refuse.

4. Estimation of Disposal Requirements

As a starting point for this study, the best possible estimate of the present generation of refuse in the County of Genesee was needed, both as to total amount and composition. The surveys previously referred to represented the best direct data available, and were carefully analyzed.

The industrial surveys provided excellent information as to the composition and quantity of refuse produced by industry. The present amount of industrial refuse was also broken down into that part which was disposed of by the owner, and the remainder which was taken care of by private contractors within the County.

The contribution and analysis of the large commercial contributors in the City of Flint and both the domestic and commercial contribution in the rest of the County were the most difficult to determine. The Engineers were forced to estimate the quantities from this portion of the contributors of solid waste based upon the information that was available from the City of Flint Department of Public Works and the surveys made by the Genesee County Metropolitan Planning Commission.

The next step was to project this data, developing estimates of probable future refuse generation, so that facilities designed for present quantities would not become inadequate before they were even completed. To do this, projections of the probable future growth of population were needed.

Among the more recent projections for County population in Michigan is Michigan Population - 1960 to 1980*. These projections

*By the Population Studies Center, University of Michigan, in cooperation with the State Resources Planning Division, Office of Economic Expansion, Michigan Department of Commerce; Working Paper No. 1, January, 1966.

were later extended to the year 2000, divided among smaller administrative units, and a new set of projections** published. These show a slackening in the rate of growth from that during the decade from 1950 to 1960. They indicate a generally uniform annual percentage increase from 1965 on, about equal to that between 1940 and 1950. They project a County population of 790,000 in the year 2000.

In addition to projections of population growth, it was necessary to project per capita generation of solid waste into the future. This is by no means a static quantity. In this country, over the past half-century, there has been a very large change in both the quantity and composition of solid wastes. A number of projections of refuse generation per capita have been made by students of solid waste disposal. Like all projections into the future, these vary over a substantial range. In preparing their estimate of the probable refuse generation in the County of Genesee, the Engineers had to weigh all of the factors which may affect it, on the basis of their experience in the field of refuse disposal. Refuse from the principal types of source was separately analyzed, and the results combined into an estimate of the total.

Having determined the total quantity of refuse we must realistically expect to be generated in Genesee County during the remaining years of the century, it remained to find out what opportunities were

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**Preliminary Population Projections for Small Areas in Michigan, State Resource Planning Program, Michigan Department of Commerce, Working Paper No. 9, November, 1966.

available for its disposal. As previously stated, the Engineers visited all existing disposal sites. Except in a few instances where permission to visit the actual site was emphatically withheld, they were able to appraise the estimated remaining life of the site and whether changes could be made in the operation to conform to Michigan State regulations. A search was also made for possible new disposal sites, and those that were found were evaluated for ease of access, availability of necessary utilities, accessibility to adequate road nets, and safety from possible water contamination. Estimates were made of the total acreage which would be required for various periods, based on certain assumptions regarding degree of compaction and possible depth of fill.

5. Tentative Preliminary Design

Having determined, as accurately as possible, the magnitude of the problem with which they had to deal, the Engineers' next step was to consider plans which would effectively deal with it, and meet the anticipated requirements of the County. Cost figures were arrived at for all of the solutions believed practicable, for purposes of comparison. On the basis of these comparisons, the Engineers were able to prepare tentative recommendations of how best to meet the needs of the entire County.

II. SOLID WASTE COLLECTION AND DISPOSAL PRACTICES IN THE UNITED STATES

According to the recommended terminology for the classification of wastes adopted in 1941 by the American Public Works Association, the word "wastes" refers to all the useless, unwanted, or discarded materials that are the inevitable by-products of our modern civilization. They may be solid, liquid, or gaseous. Solid wastes are called "refuse" and the terms "solid wastes" and "refuse" are used interchangeably in this report. Refuse may include semi-liquid or wet wastes which contain too little liquid or moisture to be free flowing. For the purpose of this study, the definition of solid wastes, or refuse, is still further extended to include those wastes, both liquid and solid, generated by industrial processes that have no salvage value, cannot be disposed of to existing sewer systems, and may be both toxic and volatile.

If the primary concern is with collection, refuse may be classified according to its point of origin, as domestic, institutional, commercial, industrial, agricultural, or street refuse. If disposal is the focus, it may be classified as organic or inorganic, putrescible or non-putrescible, combustible or non-combustible. Table II-1, on the following page, lists most of the common forms of refuse, classifies them under the headings recommended by the American Public Works Association* and indicates their usual points of origin.

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*American Public Works Association: "Introduction" Chap. 1, Municipal Refuse Disposal, 2nd Ed. Chicago; Public Administration Service, 1966.

TABLE II-1

Classification of Refuse Materials

Refuse (Solid Wastes)	Garbage	Wastes from the preparation, cooking, and serving of food Market refuse, waste from the handling, storage, and sale of produce and meats		From: households, institutions, and commercial concerns such as: hotels, stores, restaurants, markets, etc.
	Rubbish	Combustible (primarily organic)	Paper, cardboard, cartons Wood, boxes, excelsior Plastics Rags, cloth, bedding Leather, rubber Grass, leaves, yard trimmings	
		Noncombustible (primarily inorganic)	Metals, tin cans, metal foils Dirt Stones, bricks, ceramics, crockery Glass, bottles Other mineral refuse	
	Ashes	Residue from fires used for cooking and for heating buildings, cinders		
	Bulky Wastes	Large auto parts, tires Stoves, refrigerators, other large appliances Furniture, large crates Trees, branches, palm fronds, stumps, flotage		From: streets, sidewalks, alleys, vacant lots, etc.
	Street refuse	Street sweepings, dirt Leaves Catch basin dirt Contents of litter receptacles		
	Dead animals	Small animals: cats, dogs, poultry, etc. Large animals: horses, cows, etc.		
	Abandoned vehicles	Automobiles, trucks		
	Construction & Demolition wastes	Lumber, roofing, and sheathing scraps Rubble, broken concrete, plaster, etc. Conduit, pipe, wire, insulation, etc.		
	Industrial refuse	Solid wastes resulting from industrial processes and manufacturing operations, such as: food-processing wastes, boiler house cinders, wood, plastic, and metal scraps and shavings, etc.		From: factories, power plants, etc.
	Special wastes	Hazardous wastes: pathological wastes, explosives, radioactive materials Security wastes: confidential documents, negotiable papers, etc.		Households, hospitals, institutions, stores, industry, etc.
	Animal and Agricultural wastes	Manures, crop residues		Farms, feed lots
	Sewage treatment residues	Coarse screenings, grit, septic tank sludge, dewatered sludge		Sewage treatment plants, septic tanks

The major portion of municipal collection of solid wastes today deals with the first two classified items in the above table, namely, garbage and rubbish. Although the other items are important and must be disposed of, the bulk of present-day domestic and commercial refuse is made up of the first two items, and the following definitions cover these items.

Garbage is defined as the animal and vegetable waste resulting from the handling, preparation, cooking and serving of foods. It is composed largely of putrescible organic matter. The term garbage does not include food processing wastes from canneries, slaughter houses, packing plants, or similar industries. Garbage originates primarily in home kitchens, stores, markets, restaurants, hotels and places where food is stored, prepared or consumed. It decomposes rapidly, especially in warm weather, producing strong odors. When carelessly stored it provides food for rats and other vermin and serves as a breeding place for flies.

Market refuse is the result of handling, storage and selling of foods and comes from retail and wholesale stores and markets. Poultry, fish, meat, vegetable and fruit markets are the principal source. It includes large quantities of putrescible garbage along with some rubbish such as wooden crates, cardboard boxes, plastic and paper wrappings. Because of the high putrescibility of market wastes, more frequent collections are necessary to protect the fresh food supply and preserve the appearance of the community.

Rubbish consists of a variety of both combustible and non-combustible solid waste from households, stores, institutions, and commercial concerns. It is defined specifically as "combustible rubbish" and "non-combustible rubbish". When the term "rubbish" is used alone it means a combination of combustible and non-combustible rubbish. If other materials, such as garbage and ashes, are collected with rubbish, the mixture should be designated "combined" refuse.

Combustible rubbish consists of miscellaneous burnable materials. It is usually the organic component of rubbish, such as paper, rags, cartons, boxes, wood, excelsior, bedding, rubber, leather, grass, leaves, yard trimmings, plus combustible inorganics such as plastics. Since it is not highly putrescible, it can be properly stored for relatively long periods without becoming a nuisance. Having a high heat value, it will burn freely when dry.

Non-combustible rubbish consists of miscellaneous unburnable materials at ordinary incinerator temperatures of 1600 F to 2000 F. It is mainly inorganic material, such as tin cans, metals, dirt, ceramics, glass and the like. Being non-combustible, it is very stable; however, it is esthetically objectionable and may harbor rodents or other vermin when carelessly stored. Such materials as tin cans and bottles that once contained food may have a residue of putrescible material clinging to them. Usually, this residue of organic matter desiccates rather than putrifies. These containers may serve as breeding places for flies and other insects, and should be disposed of in a sanitary manner.

Yard rubbish consists of grass clippings, prunings, weeds, leaves and general yard and garden wastes. Much of the yard rubbish is green vegetation which when kept moist and stored in large quantities decomposes rather rapidly. This material may serve as a breeding place for insects under certain conditions. It normally will not sustain a fire without additional fuel.

Industrial refuse consists of solid wastes resulting from industrial manufacturing and processing operations. This waste may be both combustible and non-combustible, such as wood, plastic, rubber, canvas, cardboard, paper, rags, boilerhouse cinders, dirt, sand, pavement, glass, and floor sweepings.

Combined Refuse refers to undifferentiated solid wastes collected from homes and apartment buildings where no attempt is made to separate garbage from rubbish.

In general, the other items listed in Table II-1, Classification of Refuse Materials, are not the products of households to any significant extent. Some ashes (the residue from the burning of combustible material in domestic furnaces, stoves and incinerators) are still produced, but the increasing dependence on oil, gas and electricity as sources of heat has reduced them to a negligible quantity. What there is, is normally included in the combined refuse collection. The remaining items are usually collected either by private scavengers or by municipal forces other than the refuse collection organization.

In addition to the solid wastes described in the table and the preceding paragraphs, collection services in industrial centers sometimes have to cope with what are known as "unsewerable liquid wastes". These are not even too dry to flow; they are definitely liquid wastes, and would not ordinarily come under this discussion, but because of any of a number of reasons they are incompatible with the sewer system and must be handled otherwise. They may be too toxic, too acid, or too alkaline. They may be so inflammable as to create a serious hazard if dumped into the sewer system. Finally, they may contain solid particles which will not remain in suspension, and will accumulate at various points in the system, impeding the flow of the sewage, and requiring frequent cleaning.

Industrial waste, by and large, is taken care of by the industries producing it or by private haulers dealing directly with a particular industry and not subject to franchise or licensing by a governmental unit. Very little reliable data is available regarding the total amount of such wastes generated in the country, the kinds of wastes which industry does produce, or the disposition made of them.

A. COLLECTION PRACTICES

1. Methods of Collection

The various agencies employed by communities over the country to collect their refuse are classified by the American Public Works Association under three headings. "Municipal Collection" involves the performance of this function by city, county, village, or township employees under the supervision and direction of a regular department or official of the governmental unit involved. "Contract Collection" consists of the engagement, by the local government, of private companies under formal agreements and definite specifications to collect and haul local refuse, for which the contractors are paid from general public revenues or service fees collected by the governmental unit. "Private Collection" involves the collection by individuals or companies of refuse materials from private properties; the arrangements for such service are made directly between the owner or occupier of the premises and the collector. The collector may charge a fee or he may perform the service for some salvage value in the materials (as garbage for hog-feed), and the collector may or may not operate under license or franchise from the local governmental unit, with his fees fixed by such unit.

According to a 1964 survey made by the American Public Works Association*, municipal collection, or some combination of municipal with other types, is the overwhelming favorite. In about 37 per cent of the cities of 100,000 to 1,000,000, all collection was municipal, while nearly 44 per cent in this range used a combination of municipal and private collection. Many such cities take care of residential refuse with their own personnel, but depend on private collectors to take care of the large commercial establishments and industry. In smaller cities, the pattern changes markedly. In cities of 10,000 to 25,000, municipal collection accounts for nearly 48 per cent, but the combination of municipal with private collection, which was so popular with the larger cities, has dropped to less than 13 per cent. Contract collection, however, which was used by less than 9 per cent of the larger cities, is the preferred method in nearly 20 per cent of those in the 10,000 to 20,000 range. Similarly, while less than 4 per cent of the cities over 100,000 used private collection, 12 per cent of those in the 10,000 to 25,000 range depended on this form of collection. As might be expected, this trend continues in the smaller cities, in the 5,000 to 10,000 range. There is no important change in the percentage using municipal collection, but those using contract collection have increased to 22 per cent, and those using private collection to 20 per cent. The percentage of cities in this range using the combination of municipal and private collection is half that of those in the 10,000 to 25,000 range.

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*Refuse Collection Practice, Third Edition - Committee on Solid Wastes, American Public Works Association; Chicago, 1966, Public Administration Service.

The reasons are probably varied, but it is, perhaps, safe to assume that the smaller cities have fewer large businesses or industries, and, therefore, find less occasion to supplement their municipal collection systems with private haulers to serve these special refuse producers. On the other hand, the smaller cities often find the capital costs involved in setting up a municipal collection system excessive, and take advantage of the economies available from contract or private haulers who may serve several cities in a given region and thus make more efficient use of their capital equipment. However, the collection is arranged for, the collection of refuse from its citizens is coming to be generally accepted as a responsibility of the local government. The growing concentration of population in our cities has made it virtually impossible for the individual householder to dispose of his refuse without creating a public nuisance. Even though he can engage private collectors, the public interest is so vitally affected that the local government must, at the very least, exercise effective supervision and control.

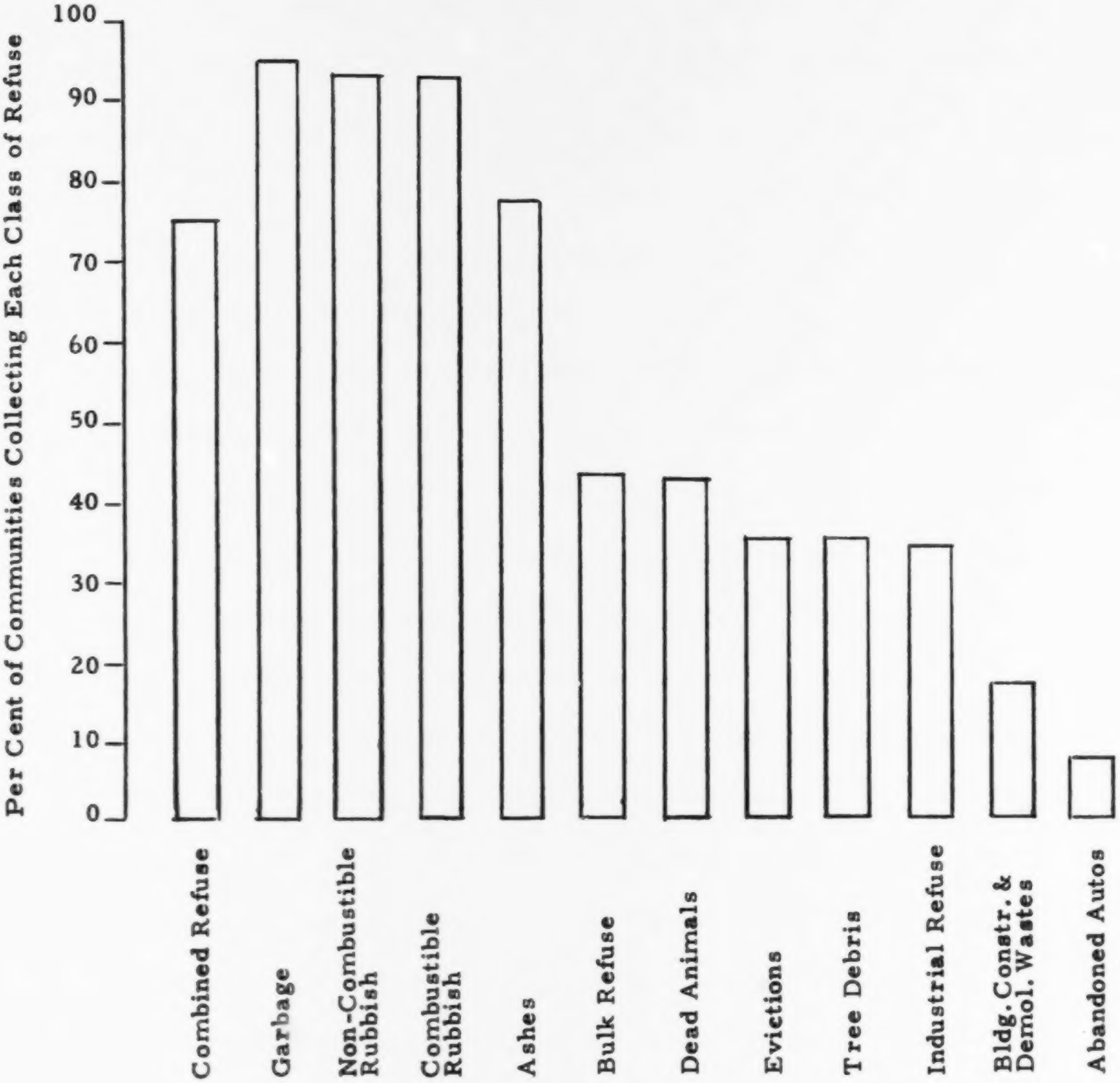
2. Variations in Services

The growth of municipal refuse collection systems has been gradual over rather a long period. Most systems began with a very limited service, which expanded only in response to public demand. As a result, a very broad spectrum of services has developed, with almost as many specific combinations of services as there are municipalities. The percentage of cities reporting collection of various classes of refuse, as reported to the American Public Works Association survey, is shown graphically in Figure II-1, on the following page. While almost all of the communities collected garbage and rubbish (both combustible and non-combustible), only about three-quarters of them did this in a single collection of combined refuse, and only about the same number included the collection of ashes. From a third to a half of these cities collected bulk refuse, dead animals, evictions, tree debris, or industrial refuse. This does not,

FIGURE II-1

COLLECTION PRACTICES

From American Public Works Association 1964 Survey of 1142 U.S. Communities having either Municipal, Municipal Contract, or Private Collections



of course, mean that the same cities collected all of these; the third that collected tree debris may well be an entirely different group of cities from the third that collected industrial refuse. Less than 20 per cent collected contractors' building or demolition wastes, and only about 7-1/2 per cent collected abandoned automobiles.

3. Receptacles for Refuse Storage and Collection

It has been said that no single feature of refuse collection has caused more concern to municipal officials than the refuse receptacle. The importance of suitable containers for storing refuse between collections cannot be over-emphasized, but many cities still lack adequate regulations, and those that have often encounter great difficulty in securing compliance. Except in the case of experiments with special containers, it is the responsibility of the occupant to provide the containers, although the owners of apartment buildings customarily provide them for all the tenants.

According to the American Public Works Association survey, a little over half of the cities to whom the questionnaire was sent reported that they specifically required householders to provide themselves with containers. The percentage requiring containers for garbage and combined refuse is, naturally, rather higher than for rubbish, which is not so likely to constitute a nuisance. Roughly, half of those specifying containers called for them to be of durable metal, and a similar number specified tight-fitting lids, while about a quarter required "suitable" handles. Of those cities which specified the size of containers, most did so by setting a maximum capacity in gallons, with thirty gallons being the preferred size, followed by the twenty-gallon size. Only from a quarter to a third specified size in terms of maximum filled weight, or minimum capacity, though these are the most logical. Containers should be limited to a weight that can be comfortably handled by the men collecting the refuse, and should be large enough so that a great number is not required to store the refuse generated in a single household between collections. A maximum weight of about 75 to 90 pounds seems to be preferred by those using this criterion, with the next largest number calling for weights between 50 and 75 pounds. The figures for minimum capacity are so scattered that it is almost impossible to detect a central tendency.

4. Frequency of Collections

Determining optimum frequency of collections in a given situation is a matter of weighing the nuisance of having refuse stored longer between collections against the added cost of more frequent pick-ups. The more frequent the collections, the fewer or smaller the containers needed, and there is less opportunity for the putrefaction of garbage, with the consequent generation of odors, and attraction of insects and rodents. The cost of covering a given route, however, varies little with the amount of refuse collected. With frequent collections, this cost applies to a smaller quantity, and the cost of collection per ton of refuse collected goes up rapidly. Furthermore, more frequent collection tends to increase the total amount collected per week, since there is less incentive for householders to dispose of some refuse otherwise.

Variations in the frequency of collection among cities are largely the result of climate and the demands of the citizens. In warm climates there is usually more yard rubbish, due to the longer growing season, and garbage putrefies more quickly. Both factors point toward more frequent collections. In communities of higher economic levels, citizens are inclined to demand, and are generally willing to pay for, better service, which includes more frequent collection. Nearly 90 per cent of the cities surveyed by the American Public Works Association collected from residences either once or twice per week with the number almost equally divided between the two frequencies. The remainder varied from one collection per month to three per week and included a number of cases where collection was more frequent during the summer months than in the winter. In some there was a combined collection during the winter and a separate collection of garbage and refuse during the warm season. As far as business establishments are concerned, 40 per cent of the communities surveyed indicated they were provided service on call, and another 24 per cent reported collections from commercial concerns daily except Sunday, or even more often. The rest ranged from one to five collections per week, with some providing special collections during an annual or semi-annual "clean-up week".

The maximum period of time between collection of refuse containing garbage should not be greater than the following:

(a) The normal time for the accumulation of the amount of refuse that can be placed in the refuse receptacle utilized.

(b) The time it takes fresh garbage to putrefy and give off foul odors under average condition of storage.

(c) The length of the fly-breeding cycle. Unwrapped garbage should be removed at regular intervals, spaced according to the minimal time required for the development of flies from nature larvae. During the hot summer months this is frequently less than 7 days.

5. Collection Equipment

The enclosed compactor truck is coming to be the greatly preferred vehicle for the collection of refuse. Approximately 90 per cent of the cities in the American Public Works Association survey reported using this type. Most of these cities used other types as well. Around 70 per cent reported the use of open trucks. These are quite satisfactory for rubbish securely tied in plastic bags, and for large and bulky items. The enclosed, non-compactor truck, which used to be the standard garbage truck years ago, is rapidly disappearing because of the far greater load that can be carried by a compactor truck of the same over-all size. Small communities often find the cost of a compactor truck excessive in view of the fact that it is a single-purpose vehicle, but where the volume of refuse is sufficient to keep it fully employed this type of truck has many advantages.

The sixteen, nineteen, and twenty cubic yard sizes are most often selected, with the trend being toward the larger units. For establishments generating a large volume of refuse, portable containers are often used, either with compactor trucks or special hoisting units. Some communities are experimenting with trains of such containers, whose loads are transferred to other vehicles for hauling to the disposal site.

6. Trends in Collection Practices

Previous surveys compared to the 1964 studies made by the Solid Waste Committee of the American Public Works Association indicate the following trend in collection practices:

(a) The increase in the amount of refuse generated has resulted in an increase in the percentage of cities presently having combined municipal and private collection system. This trend will no doubt continue as the generation of refuse per capita increases.

(b) The combined type of collection (garbage and rubbish) is supplanting the garbage-only type of collection. As the amount of garbage in the refuse continues to decrease, more and more cities will adopt the combined collection service.

(c) The refuse container for the householder is apparently standardizing around the metal container having a volume of 30 to 32 gallons, weighing slightly less than 100 lbs. when full. The material may change some in the future but the size should remain fairly constant.

(d) The enclosed compactor type collector truck appears to be the best suited for the combined type collection system, and until technology develops a better type more and more cities will adopt this type as their standard. This will probably be in the 20-25 cubic yard capacity body.

B. DISPOSAL PRACTICES

1. General

The disposal agency must coordinate its disposal program with the collection service regardless of whether the agency takes the direct responsibility for disposal, licenses or contracts with private collectors to do the work, or requires the producer to dispose of at least some refuse. The collection method utilized has a direct influence on the type of disposal service that is provided. Separate or combined collection of the various kinds of refuse, along with the frequency of collections, and other factors, must be considered in relation to the agency's responsibility for disposal.

The average municipal refuse handling agency consists of the collection and disposal of garbage, rubbish and ashes. (See the Classification of Refuse Materials, Table II-1, Page II-2.) The collection of street refuse is normally a street cleaning function, with the refuse disposal being made by municipal facilities normally operated by the Sanitation or Public Works Department. The removal and disposal of dead animals is frequently a duty of the municipal refuse collection and disposal agency; however, it is usually handled as a special rather than a routine problem. The responsibility for the removal of abandoned vehicles from the streets and/or roads is normally an operation of the Police or Sheriff's Department, with the vehicles usually being sold or given to junk dealers. Disposal of construction and demolition wastes is by and large the responsibility of the contractors in the building industry. Industrial wastes and special wastes disposal is not ordinarily considered a responsibility of the governmental agency.

For all of recorded history, the problem of disposing of refuse has been present. During most of history, the disposal of refuse has been more concerned with where than with how. An ancient Roman signpost has been discovered enscribed, "Take your refuse further or you will be fined." The refuse dumps of antiquity have revealed an enormous amount of information on the civilizations of the past.

Perhaps the real start of the refuse disposal problem, as it exists today, occurred with one of the greatest inventions of all time--the printing press. This industry utilizes a substance which is today probably the most common and plentiful of all refuse materials--paper. It has been recently reported that the Federal Government in Washington alone uses 150 carloads of paper each day. For every man, woman and child in this country, the rate of usage of paper and paper products averages more than 400 pounds per year. Most of this, one-fifth of a ton per year per person, ends up as refuse that must be disposed of.

In an urban society, the idea that the individual can dispose of refuse without creating a greater nuisance than can be tolerated has been proven unsound. As small agrarian communities grew into towns, and towns into cities, and cities into metropolitan areas, the disposal of refuse inevitably became a governmental function. Since the city residents had no interest in refuse once it was beyond their sight and smell, the disposal agency had little choice except to concentrate the nuisance by dumping the refuse on the ground at some specific location, usually known as "the dump." Because it is normal not to want to spend money on materials that are discarded as worthless, the first criterion in the selection of a method of refuse disposal was that it be inexpensive.

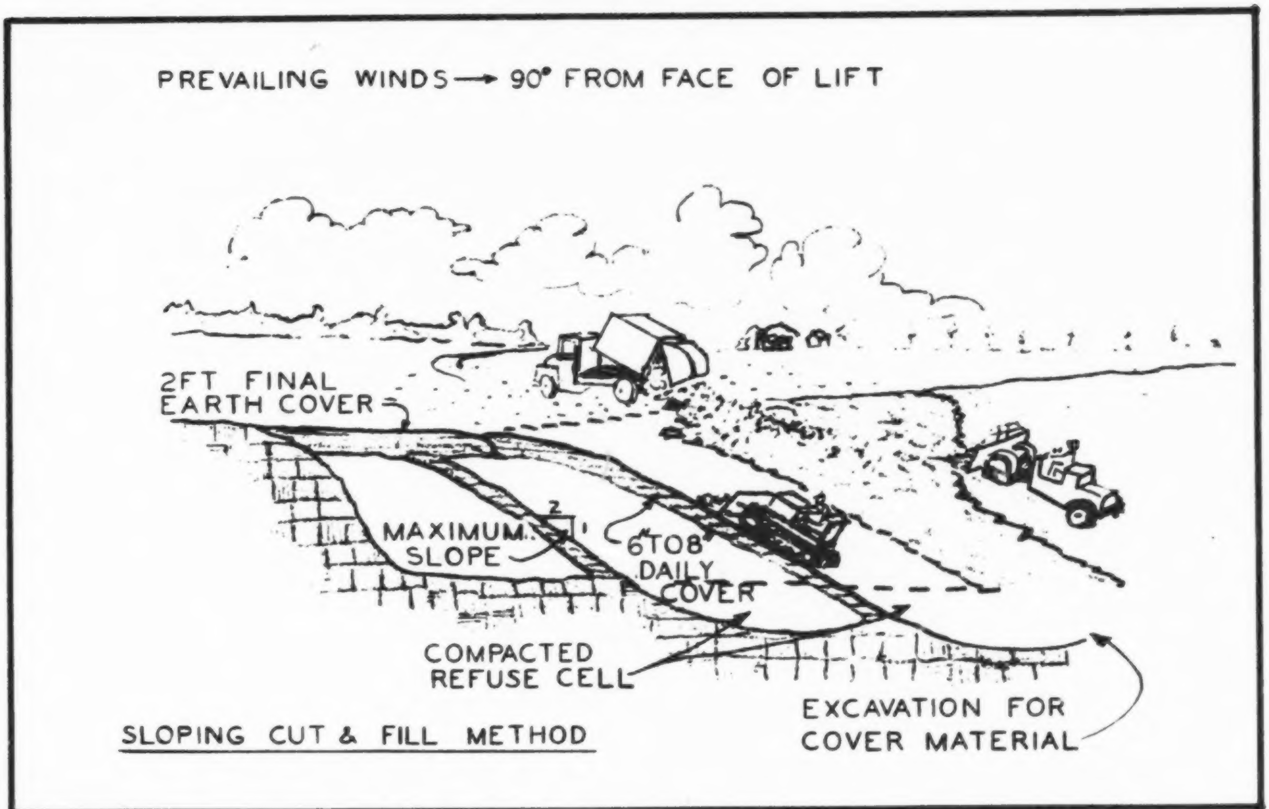
The tremendous increase in the population of the metropolitan areas has brought with it a decrease in the number of dump sites available. In many metropolitan areas, available dump sites, at reasonable hauling distances, are nonexistent. With the rapid advance in sanitary and health standards, the acceptability of primitive disposal methods can no longer be defended on the basis of low cost, yet less than one-half of the urban communities in this country with populations over 2,500 dispose of their wastes by approved sanitary and nuisance free methods.

Refuse production is related directly to the whole economy and behavior patterns of the people. Higher living standards and increased production affect, in many ways, the refuse disposal problem. Most of the country's metropolitan areas are producing solid wastes at such an increasing rate it is difficult to estimate when the rate will level off.

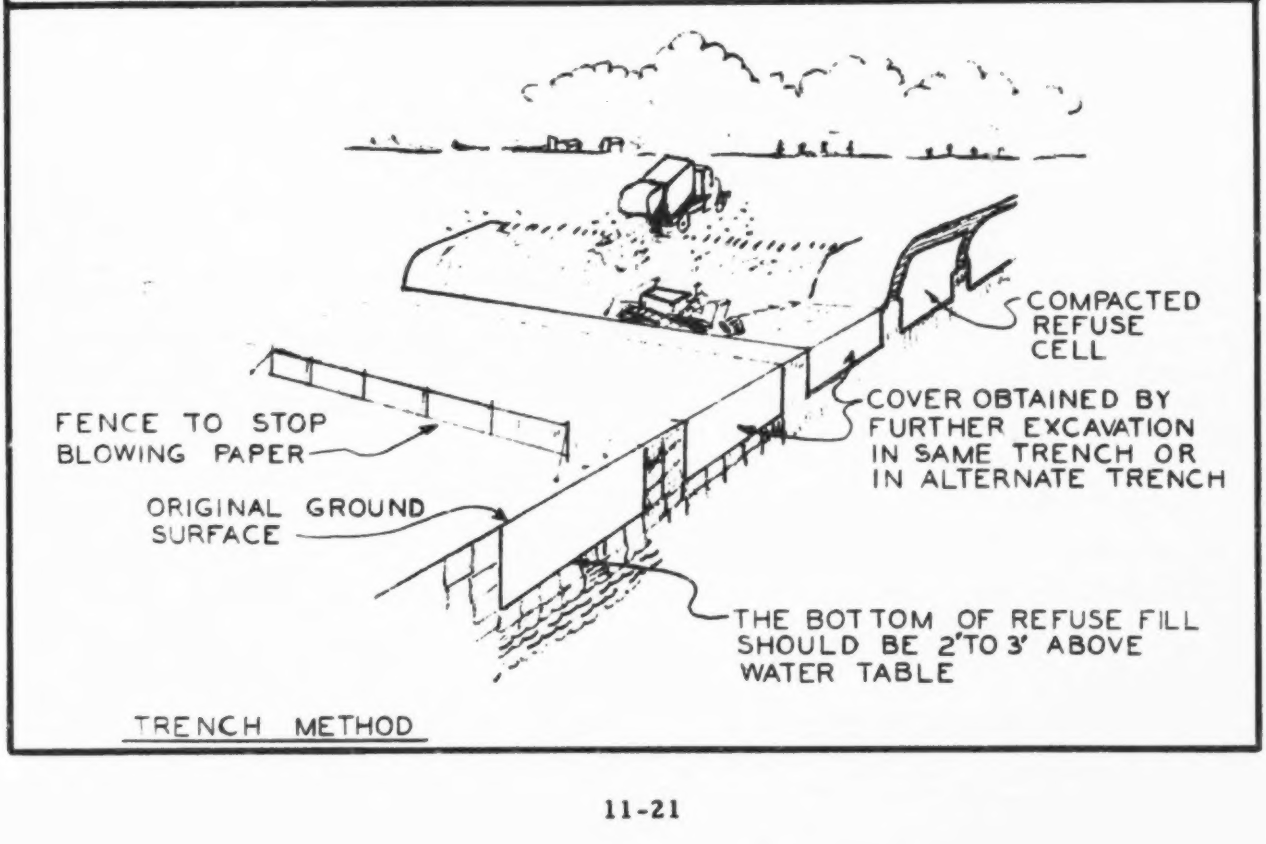
2. Disposal by Landfill

As previously pointed out, in the past the disposal of refuse has been accomplished by just dumping the material in a convenient or unused portion of land with little regard for sanitary and health standards. Today, however, the "dump" method of disposal of refuse is no longer legal in Michigan and many other states. The sanitary landfill method of disposal is recognized as both a legal method as well as a sanitary means of disposal of solid wastes. Over 1,000 cities in the United States utilize this method for disposal. Its use by a number of larger cities is, however, being terminated, due to the increasing problem of finding suitable land areas within economical hauling distances.

The illustration on the following page shows, in a general way, the acceptable types of sanitary landfill operations. The refuse is first deposited on the ground by the collector truck. Then the material is compacted to its smallest practical volume by the operation of a bulldozer or other heavy equipment running back and forth over the waste material. The compacted material is then covered with earth.


PREVAILING WINDS → 90° FROM FACE OF LIFT
2FT FINAL EARTH COVER
MAXIMUM SLOPE
2
1
6" TO 8" DAILY COVER
COMPACTED REFUSE CELL
EXCAVATION FOR COVER MATERIAL

SLOPING CUT & FILL METHOD


COMPACTED REFUSE CELL
COVER OBTAINED BY FURTHER EXCAVATION IN SAME TRENCH OR IN ALTERNATE TRENCH
FENCE TO STOP BLOWING PAPER
ORIGINAL GROUND SURFACE
THE BOTTOM OF REFUSE FILL SHOULD BE 2' TO 3' ABOVE WATER TABLE

TRENCH METHOD

To be classified as a sanitary landfill operation, the compacted waste material must be covered at the end of each day with a minimum of six inches of well compacted earth on each exposed surface. By covering each day's deposition of wastes, rodents, vermin and insects are kept to the very minimum, thereby reducing the health hazard so prevalent in the open dump method of disposal. When the various daily lifts of waste material have reached a certain predetermined height or elevation, a two-foot final cover of well compacted earth is placed over and around the compacted cells of waste material. The Michigan Act 87 of the Public Acts of 1965 Regulations Governing Solid Waste Disposal Areas specifies how a sanitary landfill shall be operated under Section R. 325. 1105.*

Many operations which are called sanitary landfills fall far short of the criteria set up in the preceding paragraph, and are, in fact, only very slightly improved open dumps. Some examples of this are the private disposal sites in Flint and the surrounding county area. These are being filled with rubbish and partially burned garbage with little or no attempt at compaction. At most of these sites, although the refuse is dumped daily, no cover material is applied until the entire lift has been completed. This leaves the refuse exposed for long

* See copy at back of Appendix.

periods, providing a breeding place for rodents and insects. At a few of these sites an attempt is being made to comply with the provisions of the law. At some, however, vermin are free to come and go as they please, and to propagate their kind.

The lack of good compaction will render these areas completely unsuitable for any type of construction for many years to come, until the natural geologic processes have had time to work. Many of these sites will probably not prove suitable even for park purposes when their refuse disposal capacity has been exhausted. These many objections to this form of refuse disposal could perhaps be tolerated if they were the unavoidable price which had to be paid for the long life of the site. On the contrary, quite the reverse is true. The proper and efficient operation of a site, according to the highest sanitary landfill standards, would extend its life by from twenty-five to thirty percent.

The two disposal operations conducted by the City of Flint, one at the west end of the municipal airport and the other at the northeast edge of the City, are both sanitary landfill type operations.

Sanitary landfill method of disposal has numerous advantages over other methods of disposal. The major advantages are as follows:

1. Initial investment cost is the lowest of any acceptable methods of disposal.
2. Operational costs are much lower than other methods of disposal.
3. Most types of refuse can be handled by sanitary landfills without initial or primary processing.

4. Peak loadings that occur during a week, month or year are readily handled.

5. Low valued or waste land can be reclaimed by properly operated sanitary landfill.

6. Air pollution problem is minimized.

There are, however, certain disadvantages that should be pointed out; these are:

1. Land requirements are very large.

2. Operational efficiency greatly effected by weather conditions - wet weather slows operation and increases costs; operations at temperatures below freezing have similar effect; dry weather creates dust problems.

3. Danger of fire is always present.

4. Danger of pollution to ground and surface waters.

5. Large amount of earth cover requirements.

6. Papers and other light material in refuse tend to blow away from operational area creating public relations problems when location is not remote from habitations.

7. Decomposition and settlement occurs over relatively long periods of time, limiting the efficient use of the filled land.

3. Disposal by Incineration

Burning, as a method of disposing of inflammable wastes, probably goes back nearly to the time when man first learned to make fire. This was, and still is in many places, done in the open, with little concern about burned or still-burning fragments that might be carried substantial distances by the wind, or the clouds of evil-smelling smoke often produced. As men began to cluster in communities, this type of open burning was frowned on as a public nuisance, and frequently banned by law in congested areas. A number of devices were put forward to overcome some of the more severe objections to open burning. One that obtained general acceptance for a number of years, and is still widely used, is the "teepee" type refuse burner, so called from the resemblance of its shape to that of the Indian wigwam. The operation of such a device is illustrated in Figures IV-12 and IV-13, on page IV-41. This is the type of equipment which comes to many peoples' minds when the word "incinerator" is mentioned.

Actually, this word, which comes from a Latin word meaning "to burn to ashes," implies a more complete combustion than is normally obtained with these devices. It should properly be reserved for a far more sophisticated piece of equipment, developed within the last century. This usually takes the form of a refractory lined furnace equipped with either manual or automatic type stoker, and provided with suitable primary and secondary combustion chambers, a tall stack and fans to increase the draft, and designed to produce an almost completely burned and inert residue. These units are intended to be operated at relatively high temperatures, and in their modern form can provide clean, odorless, smokeless, and nuisance-free reduction of unsegregated mixed refuse.

Today, in the larger metropolitan areas, central incineration has been found to be the only satisfactory method of reducing the tremendous volume of solid wastes to quantities of inert residue that can be disposed of economically.

Relatively new developments, such as continuous feed and mechanical stoking, along with facilities to prevent air pollution, have made possible installations of larger incinerators with lower operating costs. Units being designed today are not creating the nuisances that may have occurred with this method of disposal even 20 years ago. Modern units are being installed adjacent to residential areas with no ill effects other than the traffic problem created by the collector trucks.

The basic advantages of central incineration are:

a. Much less land is required for the disposal in landfills.

b. Plant can be centrally located to minimize hauling costs for collector trucks.

c. The residue contains a negligible amount of organic materials and is, therefore, nuisance free. The residue can be used for fill material.

d. Modern units can burn almost all kinds of refuse, and, in most cases, actually reduces the bulk of the noncombustibles in mixed refuse.

e. The weather does not affect, to any major degree, the operation of the incinerator.

f. There is a certain amount of flexibility in capacity for all except those plants that operate on a 24-hour, 7-day per week basis. For those plants operating at less than full-time plant capacity can be increased by operating for longer periods each day.

The major disadvantages of incineration are as follows:

a. Requires a large capital investment as compared to sanitary landfill method. Construction costs may be as high as $8,000 to $10,000 per ton of rated 24-hour burning capacity.

b. Operating costs are relatively high. Skilled personnel must be employed to operate and maintain the modern incinerators. High temperatures are necessary to operate on a nuisance-free basis, and this results in somewhat higher maintenance and repair costs.

c. Site costs are relatively high. Any refuse disposal operation seems to be offensive to most people. Consequently, obtaining land required for the operation usually has to be in high-priced industrial areas.

d. The burning of the refuse does not completely dispose of the material and the residue must be removed and disposed of by other methods.

4. Composting As A Method of Disposal

Composting is defined as a biochemical degradation or reduction of organic materials to a sanitary, nuisance-free, humus-like material. For centuries man has used leaf mold, animal manure, decayed fish and other decomposed organic matter in husbanding his crops. Only in recent times has the biochemistry of composting been sufficiently understood to apply it to municipal refuse disposal problems.

Modern scientific composting has been described as a rapid but partial decomposition of solid organic waste matter by the use of microorganisms.

Biochemical decomposition can be classified as aerobic or anaerobic, depending on whether the organisms used to accomplish it are those which thrive only in the presence of free oxygen or those which are able to grow without air or free oxygen.

Anaerobic decomposition is relatively slow and inefficient, and is the type mainly present in the domestic compost heap. It reduces organic matter primarily to minerals, humus, methane, and carbon dioxide. This process is similar to the digestion of sludge in sewage treatment, and if it is not properly controlled, causes offensive odors by the release of sulfides and mercaptans.

Aerobic decomposition is efficient and rapid, resulting in the oxidation of organic matter primarily to minerals, humus, carbon dioxide, and water. The aerobic process, properly carried out, does not produce foul odors; it is the one employed in most modern scientific composting.

All biochemical decomposition liberates heat, aerobic more rapidly than anaerobic. Where conditions are such that the heat is generated rapidly and not readily dissipated, high temperatures (up to 185° F), capable of destroying disease-producing organisms, may be attained. Such fermentation is called thermophilic, and is the result of bacteria, actinomycetes, and fungi. In natural decomposition, such temperatures are seldom produced, and the breakdown of the material is accomplished by mesophilic organisms.

There is ordinarily no need for special steps to provide the organisms, since such wastes as garbage, sewage sludge, manure, and mixed vegetable wastes normally contain enough to start the process. If the correct conditions of temperature, moisture, aeration, pH, and nutrients availability are maintained, the existing bacteria, actinomycetes, and fungi will grow and multiply, producing rapid decomposition. This process can be accelerated by recycling from one to ten percent of actively composting material as "seed". Research* indicates, however, that the addition of special "starters" or "inoculants" accomplishes little, if anything. Unless proper conditions are maintained the added organisms will not thrive, and if they are, the organisms already present will propagate sufficiently to do the job. It also appears that no pure culture which might be added can compare in composting effectiveness with the mixture of organisms normally present.

The primary purpose of a municipal refuse disposal plant is to dispose of solid wastes. Some materials, however, are difficult to decompose and require considerable time. Lignins and cellulose are usually only attacked after the more readily decomposable materials (sugars, starches, lipids, proteins) have been used up. Cellulose in the form of paper is a highly resistant material. Therefore, if combined refuse is collected, provision must be made at the plant to dispose of components that cannot be composted, such as paper, rags, metals, plastics, and glass.

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*American Public Works Association: "Composting", Chap. 9, Municipal Refuse Disposal, 2nd Ed. (Chicago: Public Administration Service, 1966).

The major objectives in composting are:

1. To stabilize putrescible organic matter.
2. To kill all pathogens and weed seeds.
3. To conserve the nitrogen, phosphorus, potash, and resistant organic matter found in the raw material.
4. To produce a uniform, relatively dry end product, free from objectionable and harmful objects.
5. To conduct the process in a sanitary manner, free from insects, rodents, and odors, and as inexpensively and in as dependable a manner as possible.

Aerobic composting, with continuous or frequent mixing, should render the final compost free of all pathogens as a result of thermal kill alone. Aside from time-temperature, there is probably a biological antagonism (antibiosis) that may render the composting matter free of pathogens at considerably lower temperatures than required for pasteurization. This should not be relied on, however, until more proof is offered, and thermal kill at 140° F for one hour or more should be used. Unfortunately, there has not yet been a conclusive study of the survival of pathogenic organisms under normal composting conditions, either in the windrow or enclosed processes.

Control of disease vectors, primarily rats and flies, is an important public health problem in waste disposal. The raw materials for composting usually attract flies and rodents and may offer excellent breeding places if not properly handled. In fact, the raw materials are likely to be infested with fly larvae when they reach the composting plant. Prompt handling of the wastes and plant cleanliness are, therefore, required.

High-rate composting can be done in two to five days using selected materials but requires a properly engineered mechanical digester. Refuse can be composted without a digester but may take ten to fifteen days. It is not necessary to compost all organic matter--only the putrescible material that attracts rodents and insects or creates odors. The remaining resistant material can be broken down in the soil where its further decomposition stimulates soil bacteria and plant growth.

The first significant development in composting as an engineered process took place in India in 1925. At that time Sir Albert Howard, in collaboration with others, systematized the procedure by which farmers and gardeners had for many centuries produced humus for use on the soil. Sir Albert's process, known as the Indore process because of the country in which it was developed, is simple. Organic wastes, such as garbage, straw, and leaves, alternated in layers with night soil, sewage sludge, or animal manures were put into pits or trenches two to three feet deep or piled on open ground to a height of about five feet. The mass was turned twice during a period of six months, and the drainage was utilized on the pile to keep the compost moist. Because the process uses principally hand labor, it has been widely used where manpower is cheap and plentiful.

Composting processes in which the principal objective was to dispose of refuse rather than to produce a humus were begun in the early twenties and a number of different processes were developed.

Dr. Giovanni Beccari of Florence, Italy patented a process in 1922. This process combined an initial anaerobic fermentation with final stages of decomposition under partially aerobic conditions. The Vendier process, developed later, was a modification of Dr. Beccari's original process, providing for the recirculation of gases or drainage liquors. A further modification of the process, to eliminate the anaerobic fermentation, was made in 1931.

In 1932 the disposal of municipal refuse was begun in the Netherlands using the Van Maanen process, in which refuse is composted in large open windrows without grinding and sorting. This process requires four to six months to complete the decomposition of the materials, during which time odors, flies, and rodents often create major problems. By combining a system of rasping, which involves grinding the refuse before composting, and turning the compost windrows occasionally, the time was reduced to approximately four to six weeks for completion of the process.

The Dano biostabilizer system is probably the most widely used process in Europe at this time. In this, the waste material usually after sorting and magnetic separation is partially composted by being held in a slowly revolving cylinder from one to five days, then finished by windrowing from two to four weeks. Several of these plants have been built, many of which incorporate revisions providing for more rapid composting because aerobic decomposition is more closely maintained during the process.

There are numerous single installations of various types of plants involving cell-type or enclosed composting and the principle of intermittent disturbance. The systems are not as efficient as those providing continuous mixing, aeration, and particle size reduction, but they may be more efficient than windrow composting.

Another method is the Buhler System, which does not provide sorting but grinds the material in a rapidly rotating hammer-mill, after which it passes to a magnetic separator, vibrating screen, roller crusher and windrows.

Little serious attention was given by officials in the United States to composting as a means of waste disposal prior to 1950. A few scattered attempts were made to import European methods. The Beccari process and its modifications were tried for a short time in Scarsdale, New York in the late twenties, but did not prove adaptable to municipal composting of refuse on a larger scale and under conditions peculiar to the United States. In 1939 a multiple deck digester of the silo type was patented. Aeration involved a combination of rotary plows and air flues, the material moving downward on a continuous flow basis. While building a pilot plant several mechanical weaknesses were encountered, and claims were made that the process was dependent upon the use of a secret and expensive inoculum.

A process patented in the United States was introduced in 1949, in which shredded organic matter was put into a fully enclosed, semi-mechanized digester intended to produce compost in 28 days under aerobic conditions. Four small experimental plants were closed down after experiencing technical problems, including difficulty in keeping the material aerobic.

In 1951 a pilot plant was built in Oakland, California. It operated for a year and led to the design of a workable plant, but local conditions prevented its construction.

During the same year, the University of California, in cooperation with the City of Berkeley, California, began a two year study of the principles of aerobic composting which went into the feasibility of composting sorted and shredded refuse, putting it in open windrows, and turning it about three times in a fifteen to twenty-one day composting period.

Between 1953 and 1956, researchers at Michigan State University conducted extensive laboratory and field experiments on composting municipal wastes, which led to the development of processes described as "modified windrow," "bin," and "area" composting.

Also in 1953, the United States Public Health Service initiated two research projects on composting, one in Savannah, Georgia and the other in Chandler, Arizona. The Savannah project has made several contributions to the basic knowledge of composting through its basic laboratory scale research. Through the operation of an experimental plant at Chandler, substantial information on the cost of refuse grinding and other material handling aspects of composting was obtained.

In 1956 a widely advertised composting plant began operation at McKeesport, Pennsylvania. After a year the plant was closed, reportedly because of technical and financial difficulties.

A process plant was built near Sacramento, California in 1957, having a 24-hour retention period followed with further maturing by windrowing or removal for direct curing. This plant has since shut down.

In 1959 a mechanical digestion system was built at Norman, Oklahoma, employing primary and secondary grinding as well as large digesters. The original design was abandoned and other practices developed, but shortly thereafter the plant closed down.

A San Fernando plant was constructed in 1961, using modifications of practices previously developed at Norman, Oklahoma, which included pulverization and windrowing. Although the company worked hard to develop markets for compost, the plant was shut down in 1965.

A biostabilizer plus windrowing plant closed in 1965 in Phoenix, Arizona after four years of sporadic operation. Although it was said that it shut down because it could not compete with landfill, operations were finally suspended two months after the City gave the operation a new contract.

At this writing there is a 300 ton per day composting plant in Houston, Texas that has been in operation for slightly over one year. Another plant at Gainesville, Florida is under construction at this time.

In all of these systems, the preparation of the solid waste is much the same. Material that might "pollute" the compost must be sorted out. This is done by magnets and by hand, using some type of conveyor system. Provision must always be made for the large amount, 30 percent or more, of material that cannot be processed--glass, plastics, metals, and other materials which would make the end product unacceptable.

Thus, at many composting operations, both an incinerator and landfill are found adjacent to the plant to dispose of the non-compostible refuse.* Obviously, to haul rejects away from an operation materially increases the cost of disposal and transportation, since it creates a parallel disposal system requiring extra pickup, transportation and disposal steps.

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* "Composting: Is It Economically Sound?" Refuse Removal Journal, July, 1966, p. 10.

Also, two more things are required for the truly successful operation of a composting plant:** first, an ample supply of sewage sludge, preferably direct from the primary settling tanks of the nearest sewage treatment plant. This normally requires a sludge pumping and metering system, a pump house, a sludge supply line of some distance, a reinforced concrete sludge thickener tank, and a distribution pipe system with automatic controls installed where required in the composting plant; second, as in the operation of a sewage treatment plant, efficient technical operation of a composting plant depends on daily laboratory tests and controls. The usual sewage treatment plant laboratory, with some additional testing equipment, as well as facilities for adding sufficient chemicals to maintain the quality of the finished product, are required. The aim of composting is to make the highest grade compost possible. To do this consistently means producing a product as near uniform as possible. Such quality control requires frequent and rapid determination of pH, temperatures, moisture and ash. Carbon dioxide production and oxygen uptake should be determined. Nitrogen, potassium, phosphorus, carbon dioxide, biochemical oxygen, chemical oxygen, and volatile solids content and demand should be determined. These two items not only will add to the capital costs, but will appreciably increase operating costs.

A composting plant, under favorable circumstances, may be constructed at a cost comparable to an incinerator plant, and operate

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** Compost Science, VII, No. 1 (Spring-Summer, 1966), VII, No. 2 (Autumn, 1966).

competitively with incineration and sanitary landfill methods of disposal. The hoped-for economy of composting comes, however, only if the end product and all salvageable material can be sold at a fair price.

Most composting plants in the United States have been built by private industry in hopes of making a profit. So far, the general plan has been for the developers to charge a municipality enough for refuse disposal at the compost plant to nearly cover operating costs. Profit, many developers believe, will come from selling the end product and salvageable material.

Thus, a compost plant operator might charge a municipality anywhere from $1.00 to $5.00 per ton for handling the waste material. But compost plant operating costs may run from about $5.00 to $10.00 a ton. As a result, not only do compost sales have to fill this differential just for the plant to break even, but they have to make more money in order to support an extensive marketing campaign and distribution network. In addition, it is doubtful whether compost can be transported any distance and still have an economic value for the seller.

Salvageable material that may have resale value includes rags, paper, rubber, ferrous metals, tin cans, non-ferrous metals, and glass. Material with no resale value includes leather, enamelware, excelsior, mattresses, matting, linoleum, sawdust, straw, dirt, synthetic fabrics, and plastics.

Rags are one of the most staple items of refuse, and maintain a fairly even price without much fluctuation. Paper prices fluctuate more than for any other salvageable material. Prices for bottles, broken glass, and rubber have not kept pace with labor cost, and would require considerable grading before they would bring a reasonable price. Ferrous metal, or scrap iron, at one time commanded a fairly high resale price, but with the advent of the electric furnace and the oxygen process in steel making, the use of the open hearth furnace and the demand for scrap has been reduced. Tin cans have a limited market value, and require de-tinning, shredding, and heavy baling to have a fair resale price. The quantity of non-ferrous metal is so small usually, that storage space must be provided until a carload shipment is accumulated.

The basic problem of composting as a method of municipal refuse disposal is how to sell and use the finished product. To date, attempts to market compost of varying qualities on a large scale in the United States have been unsuccessful. No one as yet has been able to determine definitely who will have a use for the compost. For what purpose will they use it? What products will it replace? What volume can be absorbed before demands slacken off? How many municipalities with how much daily tonnage may enter the composting business before glutting the market? How much cost for promotional, transportation, and marketing expenses may be supported by such a low priced product?

The obvious answer to who might use it is some segment of agriculture or conservation, since compost is a soil conditioner rather than a nutrient. It is possible to package compost in small bags for a limited retail market among home gardeners, golf courses, and the nursery industry, but on the large scale that compost can be produced these markets are only a drop in the bucket.

To be profitable, large amounts of the finished product must be sold to the farming industry. But, if compost is to be so used, local conditions, habits, and practices must be considered. Soil, climate, rainfall, tilling methods all have a substantial effect on fertilizing. This means extensive research must be carried out on a local level. Until farmers have personal experience with a product, they are likely to be unwilling to pay much for it. It will take time to acquaint potential buyers with compost, determine its value in a given area, and build up a demand for it. It is unrealistic to think compost can at first be sold at high prices or that all of it can be sold in small quantities to backyard gardeners.

In addition to chemical fertilizers--which compost cannot replace--farmers have long put organic material back into depleted soils. There are two major ways that this is usually done; one, by adding stable manure in one form or another (and it should be realized that about 2 billion tons of animal and poultry manure are produced annually in the United States), or two, by planting green crops and plowing them under. This cover crop is often called "green manure". Soil scientists agree that compost--even enriched with sewage sludge or animal wastes--cannot match the economy, ease, or quality of these traditional practices.

The organic content of compost is the chief interest for agriculture. This, of course, comes from the input of organic matter during the process, which will vary with the refuse delivered to the plant. Every year the proportion of organic food waste in municipal refuse declines. A well-known research laboratory tested the product from a composting plant now shut down and found only 25 percent organic matter.* The remainder was nondescript "filler" which was not even very efficient as a water-retaining substance.

Furthermore, applying compost to farm land is difficult, and there is no suitable equipment--mainly because there has been no demand for it. Compost must also be "clean" to be used in agriculture and the other industries. If it contains non-combustibles, the value is severely reduced. Glass splinters make it almost useless unless they are ground very fine--and this extra grinding costs more money.

There may also be long periods when compost demand will be light, creating huge inventories as the plant continues to make the product. Large volume output of compost would work to lower prices, and it has been the low-priced finished product which has long undermined the entire economic structure of composting, both in the United States where many privately financed projects have shut down and in Europe where composting is heavily subsidized to maintain the low-cost end product.

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* Editorial, Refuse Removal Journal, July, 1966, p. 11.

One important reason for the failure of so many compost plants has been not the lack of technical knowledge, but the inability of the plant operators to dispose of the finished product. This problem of utilizing compost has been, and still is, a major deterent to its adoption as a major method of disposal. Another reason has been the inability of the investor to recognize the true cost of operating a composting plant. There has also been a tendency on the part of those advocating composting as a method of disposal to ignore the large volume of non-compostible refuse produced which must also be disposed of.

5. Trends in Disposal Practices

As both sanitation and health standards have been upgraded, the "City Dump" has come in for its share of criticism as a source of disease spreading flies, rodents and vermin of all kinds. As city after city has faced up to the problem, better methods of disposal have been developed.

Since the second World War there has been a tremendous increase in the use of the sanitary landfill type method of disposal by cities of almost all sizes. This method is probably the lowest in cost of any of the accepted sanitary methods of disposal where adequate land is available within economical hauling distance. As the public conscience becomes more aroused to eradicate unsanitary methods of disposal, the use of the sanitary landfill will no doubt increase in the smaller urban areas where land is still available close to the points of generation. The State of Michigan is in the forefront with the enactment of the Solid Waste Disposal Act previously mentioned.

In the larger metropolitan areas the incineration method of reducing the volume of refuse is being utilized to a larger percentage than ever before. With modern methods of burning and air pollution control, this method of disposal will continue to increase.

Since the characteristics of the material are continually changing due to our technology of manufacturing and processing, it is difficult to predict that form of disposal which will be developed in the future. Much research into methods of disposal of solid wastes is presently under way, financed wholly or in part by demonstration grants from the Office of Solid Wastes, Public Health Service, U.S. Department of Health, Education and Welfare. When the results of this research are available perhaps present-day methods will prove outmoded, but until that time large scale refuse disposal will probably utilize sanitary landfill and/or incineration with minor modifications for special wastes.

III. FACTORS AFFECTING FUTURE REFUSE MANAGEMENT

A. ECOLOGICAL FACTORS

1. Population Trends

One can scarcely read a newspaper or a magazine these days without encountering a reference to the "population explosion". The population of this country has, for many years, increased in geometric progression. Genesee County has, except for the depression decade of the thirties, followed this general pattern, with an average increase of nearly 45 per cent each decade since the turn of the century.

Most of this growth has taken place in the metropolitan complexes, although the number of people within the corporate limits of our great cities has tended to remain stationary in the main, with a few cities actually losing population. It is a truism to say that the more people you have in a given area, the more refuse they will produce. The production of wastes of all kinds has reached alarming proportions in this country, and their disposal is rapidly approaching a state of crisis. There is little evidence to suggest that this trend will be reversed in the lifetime of anyone now living, short of world catastrophe.

2. Urbanization

Coupled with the phrase, "population explosion", one often hears another, "urban sprawl". Our major cities are spreading out over the surrounding countryside at a rate that has led many students of these problems to suggest that this country will soon be covered by perhaps a dozen vast metropolitan complexes to which they have given the name "megalopolis". Along with the static population of the central cities, there has been a phenomenal growth in the suburban areas surrounding them. Genesee County is no exception to this general trend. In the twenty years from 1940 to 1960, the City of Flint had a population increase of about 30 percent, while the surrounding county more than doubled its inhabitants. More and more the outlying portions of the county are taking on an urban appearance, and the conditions of life are approaching more nearly to that of a city.

This trend has created massive problems in the disposal of refuse. Not only is more and more refuse being generated, but at the same time an even larger part of the land area is being occupied. No longer are there convenient ravines in the back forty where wastes can be thrown. That same ravine has now been cleaned up and is the prized scenic feature of a luxurious suburban home.

3. Trends in Refuse Generation

The total refuse generated per capita has been steadily increasing in this country as the general standard of living has risen. A recent study conducted for the U.S. Public Health Service by Combustion Engineering reports approximately 1 billion 380 million pounds of residential, commercial and industrial wastes, or 5.1 pounds per capita, are generated in the United States each day.* Unless there is a drastic change in the economy of the United States, it is reasonable to expect that this trend will continue. This fact, taken with the factors already mentioned, compounds the problem of refuse disposal.

Not only the total quantity of refuse is changing, but the typical make-up has altered materially. Most foods are now bought in some pre-packaged form. This substantially decreases the food waste which formerly made up a large part of domestic refuse collection. In addition, it has increased the amount of packaging materials to be disposed of enormously. The type of packaging material has also changed radically. Where before it was almost entirely paper and cardboard, now a very large part of the packaging material found in a typical refuse collection consists of various forms of plastic. This is true not only of food products, but of many of the things the householder buys. Items of hardware which were formerly bought off a shelf and wrapped in a paper bag now come in neat, transparent, plastic packages that are almost impossible to open. Photographic equipment often arrives nestled in a bed of cast plastic foam. The list could be extended indefinitely. And all of this material must be disposed of some way. This changing composition of refuse has a profound effect on the choice of a disposal method, and must be carefully considered in any long-range planning.

*Solid Waste Management Refuse Removal Journal, Page 22, March, 1968, RRJ Publishing Corp.

4. Land Use

With the growing scarcity of vacant land, it becomes imperative that all land be used for the greatest good of all the people. A disposal method which removes the land from other use for long periods after its capacity for the disposal of refuse has been exhausted can no longer be tolerated. Refuse disposal must be conducted in such a way that the land can be converted to other uses in the shortest possible time. It is possible to design the operation of disposal sites so that the land can be used for recreational purposes almost immediately after being filled. After a much longer time, such sites may also be available for certain types of building construction.

B. LEGISLATIVE REQUIREMENTS

1. Collection

Until recent times, there has been little legislation directly affecting the collection of solid wastes. The principal bearing of legislative enactments on this aspect of the problem is indirect. This includes the laws about public nuisances, and requires that collection be so managed as not to produce unpleasant odors, nor to attract insects or other vermin. Legislation responds to public pressure in this field as in others, and it is quite likely that laws may be passed in the future which will bear more directly on the collection of refuse.

2. Disposal

All of the legislation referred to under Collection has the same indirect bearing on the handling of disposal. They are apt to be more strictly applied, however, because refuse passes rather rapidly through the collection department, but remains indefinitely where it is disposed of. The opportunities for the dispersal of unpleasant odors, and for the attraction of vermin, are far greater in a poorly run disposal operation, therefore, than in even the most casual collection procedure.

In addition to this indirect effect, there has been a substantial body of legislation aimed directly at the regulation of refuse disposal. The State of Michigan has adopted Act 87 of the Public Acts of 1965 authorizing the Department of Public Health to establish Regulations Governing Solid Waste Disposal Areas.* These regulations govern the disposal of all kinds of refuse throughout the state. Open dumps will no longer be allowed. All disposal areas will have to comply with these regulations or more stringent ones if the local authorities enact more stringent rules. Open dumping in the ditches along county roads has been observed. This is a kind of thing that is very hard to stop, since the culprits must be caught red-handed. The feeding of raw or uncooked garbage to any animal to be used to supply food for human consumption is also prohibited. Standards are set for the sanitary and nuisance-free operation of disposal sites.

Another problem of our ever-more industrial and urban civilization which has a bearing on refuse disposal is that of water pollution. The putrescible and compostible material in domestic and commercial mixed refuse decomposes, some at a relatively rapid rate

*See copy at back of Appendix.

and some at a much slower rate. This decomposition produces both chemical and bacterial pollutants. Therefore, it is imperative, especially when mixed refuse is disposed of in a landfill operation, to guard against contamination of ground water and streams.

Ideally, deposition areas should have very low permeability so that products of decomposition of the refuse would be essentially contained within the disposal area. Such an ideal site should also have very little rainfall to eliminate the possibility of any runoff from the disposal area. To obtain such an ideal site in Genesee County, as well as in most other areas in the Central United States, is almost impossible. Therefore, it is imperative that special care must be exercised in selection of disposal sites. As discussed in Section I, the geological structure of most of the county is such as to cause some degree of flooding throughout the entire county. In the southern portion of the county, where numerous marshy areas exist, large sanitary landfill operations could create pollution problems, since most of the area drains into the numerous small lakes located there. In the balance of the county it is difficult to locate large areas that could be utilized for sanitary landfill operations due to the large number of small streams, creeks and brooks that interlace the region.

Fortunately, the amount of putrescible and compostible material in normal mixed refuse in the Northern United States has been decreasing over the past three or four decades. This, of course, tends to lessen the danger of pollution. There are, however, dangers of contamination in some of the industrial solid wastes generated within the county. Indescriminate deposition of such industrial waste may create far greater hazards than the pollutants that might be generated in the normal mixed refuse.

Both the disposal sites and the methods of disposal must be approved by the Michigan Department of Public Health prior to selecting and acquiring sites. To date, there has not been sufficient research done to acquire complete knowledge of the chemical and organic constituents in the various types of solid wastes disposed in landfills. Nor is much understood of the geochemistry of earth materials that determines the attenuation of contaminants that may result in a particular physical environment.*

C. SPECIAL TYPES OF REFUSE

1. Trees and Shrubs

The disposal of trees, in particular, has taken on major proportions since the spread of Dutch Elm Disease in this country. Dead trees and shrubs are bulky and awkward to handle, and they are not a particularly suitable material for landfill. Large logs, especially, burn relatively slowly, so that disposal in regular refuse incinerators is not a completely satisfactory solution either. At present, this type of material is dumped in landfill sites where it seriously interferes with proper sanitary landfill operation because of its bulk and resistance to compaction. Disposal of this material is a factor that must be considered in any over-all survey of waste disposal in Genesee County.

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*Sanitary Landfill - Principles of Design and Operation - Training Course Manual in Solid Wastes (1968); Public Health Service, U.S. Department of Health, Education and Welfare.

2. Dead Animals

Dead animals present a special problem, since they cannot be permitted to lie around awaiting the next regular pick-up. Furthermore, it is extremely important for the health of the entire community that they be disposed of in such a way as to eliminate any possibility of the transmission of infection. "Pet Cemeteries" are springing up in some parts of the country, but they take care of only a very small portion of the animals that require disposal. In some metropolitan areas, Doctors of Veterinary Medicine are able to provide cremation service for treasured pets and to return the ashes in containers in which they can be buried with no health hazard. However, the cost of this service eliminates it from consideration for a large majority of the dead animals which constitute a disposal problem in our cities.

3. Junk

Under this heading are lumped a wide variety of large and bulky items which have outlived their usefulness, or are too badly damaged to be worth repairing. Old and broken furniture, not yet old enough to be considered "antique" and, consequently having no resale value, makes up a substantial part of this category. Household appliances that have become obsolete, and for which parts can no longer be obtained, contribute another large share. As far as some of the householders in Genesee County are concerned, this is taken care of in the special pick-ups in their annual "Spring Clean-Up Week". This takes it off the hands of the individual homeowner, but the collecting agency still has the problem of what to do with it. Some such material will undoubtedly possess some slight salvage value, but whether it will be sufficient to pay the costs of sorting the material is very doubtful.

A supplement to this report is being prepared to analyze the junked car situation in Genesee County. It is hoped the disposal of junked and abandoned automobiles may be in the process of being solved. In a number of our larger cities crushing and shredding plants have been installed by private enterprise that produce a salable scrap metal from cars. Most of these installations are close to or within easy shipping distance of steel mills. As more of these plants are developed it may be possible to rid the countryside of the rows upon rows of obsolete and junked vehicles that dot the landscape.

It may also prove economical to process the junked large appliances by this method and produce a usable scrap metal. Just the crushing of these large pieces of junk would assist in its disposal. However, the cost of crushing without providing a salable end product to offset the cost is still too high for the average urban area to consider.

4. Poisonous, Highly Inflammable or Explosive Wastes

These are wastes which, for obvious reasons, require special handling. Fortunately, they represent a relatively small part of the total refuse problem, but they cannot be ignored. Much of this type of waste comes from industry, and the manufacturers have already had to find a way of dealing with those wastes in this class which they produce. Any over-all plan of solid waste disposal must consider this problem of dangerous wastes disposal.

5. Construction and Demolition Debris

This includes all the waste material that is an inevitable by-product of any construction project. It is the responsibility of the contractor, in almost every case, to remove it from the premises, but then he has the problem of disposing of all of it that is not salvageable. Material removed from excavations is ordinarily no problem; it often constitutes excellent cover material for a sanitary landfill operation. It is the scrap lumber from scaffolding and formwork, packing materials, and such odds and ends that make up the serious disposal problem. Where construction has been preceded by demolition, there is often a large amount of old, broken, brick, stone, concrete and lumber which must be taken somewhere. If there is enough fine material to fill the voids between the larger pieces of non-combustible material, this can be satisfactory fill, provided there is enough depth at the disposal site so that it can be topped off with a substantial layer of well-compacted earth.

IV. REFUSE MANAGEMENT IN GENESEE COUNTY

A. REFUSE GENERATION

1. Present

In order to logically analyze the problem of solid waste collection and disposal in Genesee County it is necessary to know the quantities being produced. As pointed out in Section I, only in the City of Flint has there been any recording of the mixed refuse quantities being collected from the residences and small commercial establishments. If the private collectors have kept records of quantities collected they did not so indicate in the discussions with the Engineers.

Since only a portion of the commercial establishments within the City of Flint have collection service performed by the City's forces, other means had to be adopted in estimating the quantities of solid waste generated by this segment of the economy.

Industrial solid waste generation forms a large percentage of the County's total generation. Industry, realizing this, made a very thorough survey of their generation and provided invaluable information to the Engineers.

Summaries of the data obtained from the various sources of solid waste will be found in the following paragraphs:

(a) Domestic or Residential Refuse Generation

Since the City of Flint's Department of Public Works does maintain records of the cubic yardage of refuse going into the City's two sanitary landfill sites, and since the private collectors do not maintain records of collection or disposal quantities, it was not possible for the Engineer to obtain actual generation figures for the entire County. Estimates had to be made of the domestic generation from the data available.

The Department of Public Works provided the following records of cubic yardage for the years 1966 and 1967 estimated deposited in the two sanitary landfill sites operated by the City. These yardages represent all collections of mixed refuse from the domestic and small commercial establishments in Flint.

CITY OF FLINT SANITARY LANDFILLS

	Quantity - Cu. Yds.	
Month	1966	1967
January	13,296	14,312
February	12,826	11,870
March	13,264	14,888
April	13,886	14,906
May	13,982	15,006
June	14,138	15,312
July	21,152	22,242
August	14,062	14,288
September	14,184	15,016
October	13,560	14,982
November	14,476	15,798
December	21,662	23,284
Total	180,488	191,904

% Increase 1967 over 1966 - 6.33%

The Flint Department of Public Works also weighed all loads collected during a week in January, 1966, and a week in July, 1967. The total weight of refuse collected in these two week periods is shown below:

COLLECTION - CITY OF FLINT, MICHIGAN

Period	Total Pounds Collected
January 10 through 14, 1966	1,034,560
July 17 through 21, 1967	1,797,780

Examination of the cubic yardage of mixed refuse collected for the months of January, 1966 and July, 1967 were 13,296 and 22,242 cubic yards, respectively. Since each month had 4.2 weeks, the density per cubic yard based upon the above weekly weights is as follows:

For January, 1966

1,034,560 lbs./wk. = 328 Lbs./Cu. Yd.
13,296 cu. yds.
4.2 wks.

For July, 1967

1,797,780 lbs./wk. = 339 Lbs./Cu. Yd.
22,242 cu. yds.
4.2 wks.

Average Yearly Density $\frac{328 + 339}{2}$ = 333 Lbs./Cu. Yd.

Since the average monthly density for both January, 1966 and July, 1967 are almost equal, it appears that the calculated average yearly density is very reasonable.

Using the calculated average yearly density of the mixed refuse collected in Flint and the reported total cubic yardage collected in 1967, the total estimated pounds collected by the City in 1967 equals:

191,904 Cu. Yds. x 333 Lbs./Cu. Yd. = 63,900,000 Lbs.

The above estimated collection by the City of Flint includes both domestic and small commercial generation. Examination of the collections from the small commercial routes for both the week in January, 1966 and the week in July, 1967 plus the actual weight of the small commercial collections made on March 1, 1968 indicate that the small commercial generation varies between 50,000 lbs. per week and 75,000 lbs. per week. Taking the higher figure, the estimated residential refuse for the year 1967 would be:

63,900,000 Lbs. - (75,000 Lbs./Wk. x 52 Wks.) = 60,000,000 Lbs./Yr.

Using an estimated average population for the City of Flint of 210,000 for the year 1967, the generation of residential refuse per day would be:

$$\frac{60{,}000{,}000 \text{ Lbs./Yr.}}{210{,}000 \text{ Pop.} \times 365 \text{ Days/Yr.}} = .79 \text{ Lbs./Cap./Day}$$

Say - .80 Lbs./Cap./Day

The estimated 0.8 lbs. per capita per day for the City of Flint's domestic generation of mixed refuse appears low when compared to national averages as well as to the generation the Engineers have found in other cities both larger and smaller than Flint. After questioning a number of residents of the City, and making observations of the residents' habits regarding disposal of refuse, the Engineers came to the conclusion that not all of the refuse generated within the homes of the residents was being collected by the City. Almost without exception, residents stated that they burned some papers from one to two times a week. This was the custom in spite of the fact that the City provides a combined collection. Apparently, many residents were in the habit of burning papers before the City went to a combined collection and have continued the practice; or they prefer to burn these wastes rather than bundle and tie them as required for collection. This custom is no doubt practiced outside the City of Flint in the areas served by the private collectors.

To further check the quantity of paper disposal the offices of the Flint Journal and the Detroit News and Detroit Freepress were contacted to determine the number of newspapers sold in the County. Although both Detroit newspapers were not being published at the time of the survey due to a strike, both papers supplied information as to the number of daily and Sunday papers sold in Genesee County prior to cessation of publication. Based on the average number of pages, the Detroit papers amounted to approximately 0.05 lb. per capita per day of newsprint. The Flint Journal's paper amounted to about 0.27 lb. per capita per day, or a total of approximately 0.32 lb. per capita per day.

Based upon the above quantities of newsprint, it is the Engineers' opinion the estimated 0.8 lb. per capita per day generation of domestic mixed refuse should be raised to 1.0 lb. generated per person per day. The increase of 0.2 lb. should also be added to the estimated quantity of paper generation. This figure will be used as the starting point in estimating future generation.

The Engineers, during the study, supervised two sampling surveys of domestic refuse collected by the Flint Department of Public Works described briefly in Section I. The three selected collection routes were considered representative of the total City. Records were kept of the number of residences served on each collection route, the number of garbage containers, paper bags, bundles of paper, etc., picked up on each route. After weighing the collector truck load from each route, the contents were dumped out, then segregated into the various classifications of refuse. The various classifications were then re-weighed to determine the amount of each classification from the individual route. Figures IV-1 through IV-4, on pages IV-10 and IV-11, are photographs of the summer of 1967 sampling operation. From actual surveys of the residents on each collection route and from U.S. Census tracts, the Engineers determined the average number of persons in each family or residence. With the percentages of the various classifications of refuse and the number of persons contributing a composite sample was determined for the total City. Table IV-1, on page IV-7, shows the physical analysis of the composite samples for the two periods and an annual average composite sample of Flint's domestic refuse.

TABLE IV-1

PHYSICAL ANALYSIS OF DOMESTIC REFUSE BASED ON A COMPOSITE OF SAMPLES COLLECTED IN FLINT, MICHIGAN

Classification	Percent by Weight		
	Summer(1)	Winter(2)	Annual Average(3)
Garbage	29.1	36.0	32.6
Paper, Magazines, Cardboard	13.8	21.1	17.5
Plastics, Rubber, Leather	1.9	2.6	2.3
Rags	0.3	0.8	0.5
Lumber and Wood	1.0	0.8	0.9
Garden Clippings and Brush	26.7	0.3	13.5
Cans and Metal	14.5	14.5	14.5
Glass	12.7	23.2	17.9
Ashes	0	0.7	0.3
Combustibles	72.8	61.6	67.3
Non-Combustibles	27.2	38.4	32.7

Notes

(1) Summer Composite Percentages based on samplings made June 14, 15, and 16, 1967.

(2) Winter Composite Percentages based on samplings made January 17, 18, and 19, 1968.

(3) Annual Average Composite based on summer composite percentages for 5 months and winter composite percentages for 7 months of the year.

It should be pointed out that both the summer and winter composite analysis indicate much higher percentages of garbage than is normally seen in residential mixed refuse today, which usually ranges from some 8% to 12%. Also, the percentage of paper both summer and winter is much lower than normal. Since the practice of burning papers appears to be normal in Flint, this would explain partially the reason for the relatively low percentage of paper.

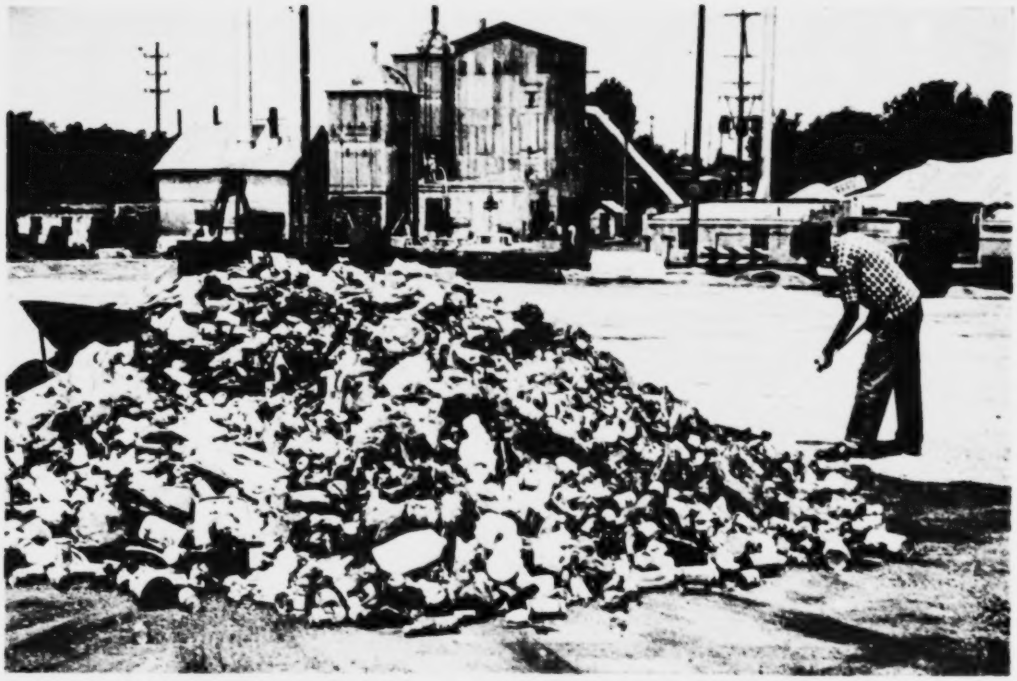
One other practice by the householder in Flint may also effect the percentage of garbage. Examination of the segregated refuse from each of the six truck loads showed a large number of cans, glass jars and milk cartons completely packed with garbage and grease. It was impossible in the weighing process to remove this packed material from the containers; therefore, the cans, glass jars and milk cartons had to be weighed along with the garbage and an estimate made of the weight of the containers, which was then subtracted from the total weight of garbage and added to the proper classification. This, of course, could introduce some error, since estimates had to be made. However, the Engineer feels after examination of the segregated refuse both in the summer and winter that Flint householders do generate more garbage per capita than they have found in other cities of comparable size.

Increasing the paper by the estimated 0.2 lb. per capita per day previously discussed results in a physical analysis as shown in Table IV-1A, below. The percentages are based on the annual average composite analysis given in Table IV-1. It is the opinion of the Engineer that this estimated physical analysis of domestic refuse is representative of the entire County and is used hereafter in all determinations of required capacities.

TABLE IV-1A

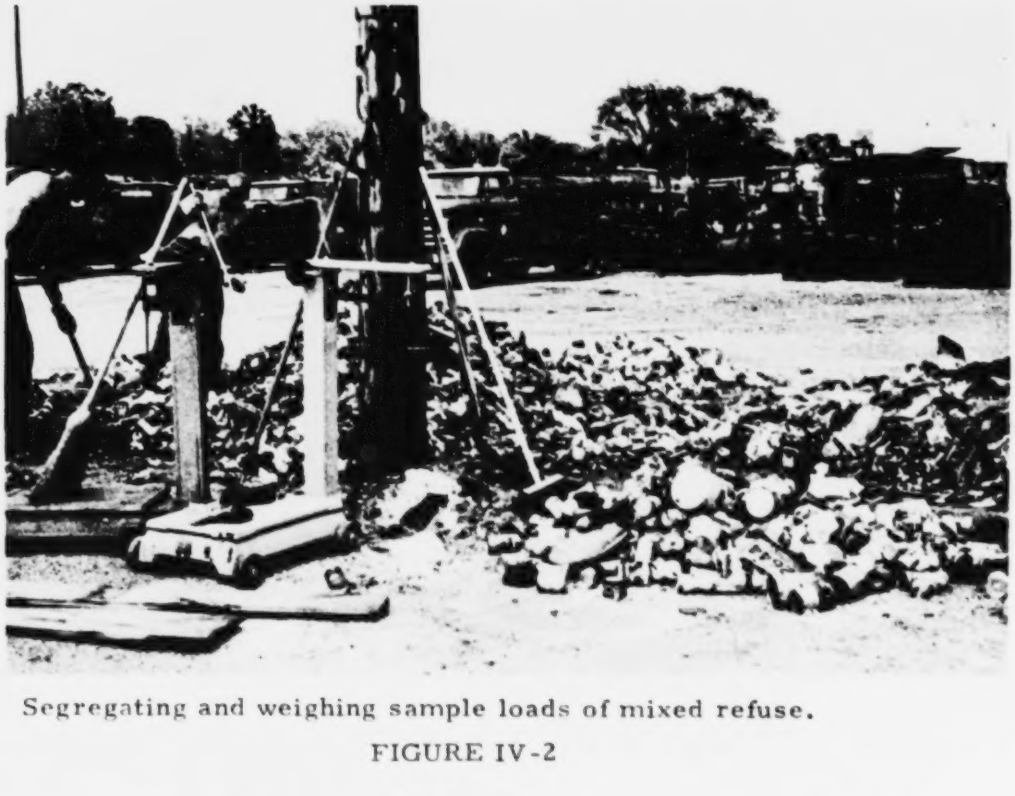
ESTIMATED PHYSICAL ANALYSIS OF FLINT, MICHIGAN DOMESTIC REFUSE

Classification	Percent
Garbage	26.0
Paper, Magazines, Cardboard	34.0
Plastics, Rubber & Leather	1.8
Rags	0.4
Lumber & Wood	0.7
Garden Clippings & Brush	10.8
Cans & Metal	11.8
Glass	14.3
Ashes	0.2
Combustibles	73.7
Non-Combustibles	26.3



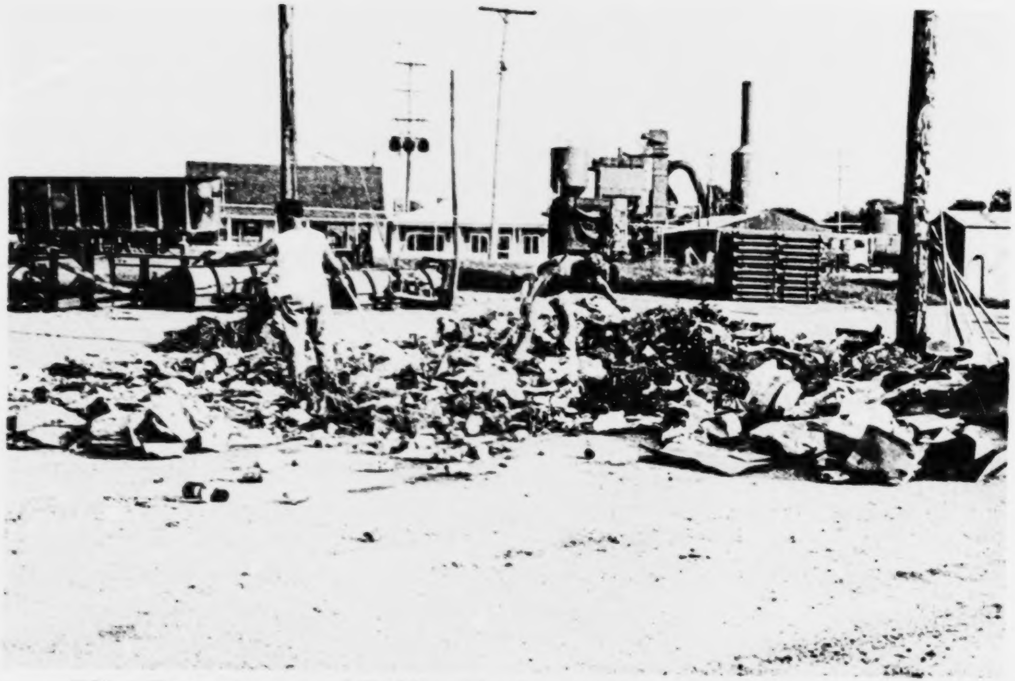
Segregating municipal refuse for analysis. Flint Department of Public Works.

FIGURE IV-1



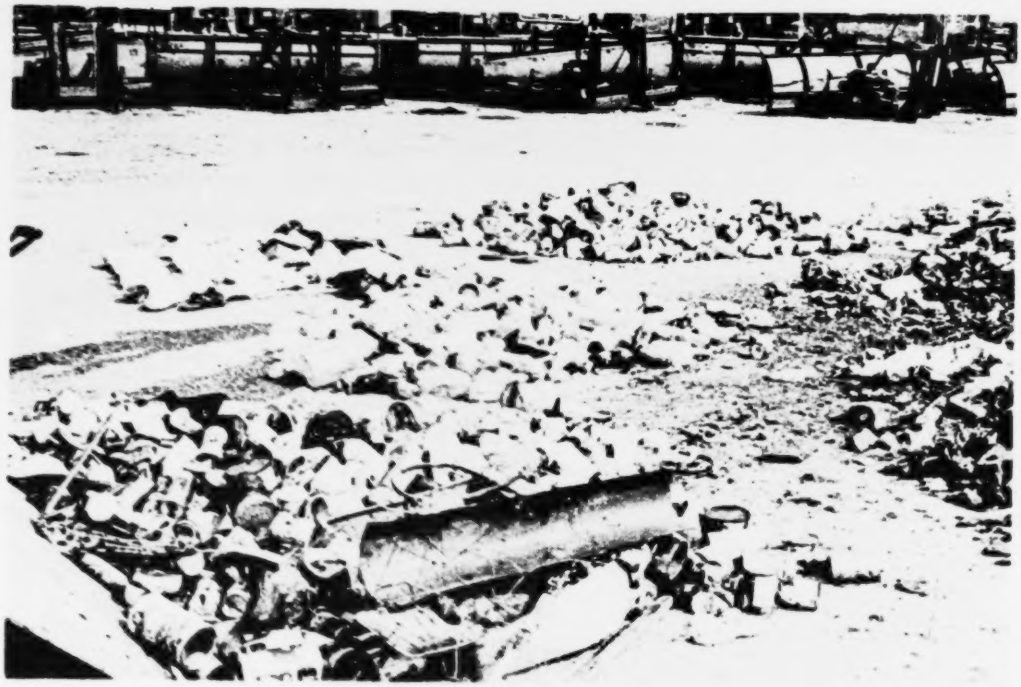
Segregating and weighing sample loads of mixed refuse.

FIGURE IV-2



Flint Department of Public Works employees dividing typical municipal refuse into groups.

FIGURE IV-3



View of segregated refuse. Note plastics, glass and cans removed from mixed refuse.

FIGURE IV-4

(b) Commercial and Institutional Refuse Generation

As briefly discussed in Section I, in order to determine the generation of commercial and institutional refuse questionnaires were sent to some four hundred and forty-eight establishments in the City of Flint by the Genesee County Metropolitan Planning Commission. A copy of the questionnaire is included on page -i- of the Appendix. Two hundred and fifty-three of the questionnaires were returned with some or all answers to the questions asked. This represented approximately 5% of commercial and institutional establishments in Flint.

A number of the returned questionnaires were incomplete, especially question No. 12, "How much solid waste do you generate per week?" Seventy-two of the questionnaires had no answer or the statement "none". One hundred and forty-six gave some information as to the volume of solid waste generated per week. These answers were in gallons, cubic feet, cubic yards, bushels, etc. Only thirty-five answered this question in weight. Fifty-six indicated they had a private incinerator or approximately 22% of the total number replying.

The returned questionnaires were separated into the various classifications according to the listings in the classified directory, which listed some 4,880 establishments. For those classifications where sufficient information as to quantity of refuse was given on the returned questionnaires the Engineers used this as the average contribution. Where insufficient information was available the Engineers used data available from other surveys as the average contribution for that classification. As a further check, representatives of the Engineers followed trucks of both the Flint Department of Public Works as well as private collectors on their commercial routes estimating quantities and approximate analysis of the commercial refuse picked up in one day each in July, 1967, January and March, 1968. From this information they further refined the estimates of generation. Listed in Table IV-2, on page IV-14, are the number of establishments taken from the classified directory, their estimated average generation per week, and the estimated total weekly generation of mixed refuse by the business firms and institutions in Flint. The 1,027,000 lbs. per week estimated as the generation from the City of Flint is used to develop the estimate of the entire County's generation.

TABLE IV-2

ESTIMATED GENERATION OF SOLID WASTE BY COMMERCIAL AND INSTITUTIONAL ESTABLISHMENTS CITY OF FLINT, MICHIGAN

General Classification	Number	Estimated Avg. Generation Lbs. /Wk.	Estimated Total Generation Lbs. /Wk.
Apartment House	23	1,150	26,450
Auto Sales	100	14	1,400
Beauty Shops	341	20	6,820
Church	228	11	2,508
Contractors	500	40	20,000
Dance Studios	12	8	96
Department Store	110	60	6,600
Grocery	182	40	7,280
Hospital	13	24,200	314,600
Office-General	1,000	16	16,000
Office-Physicians	410	8	3,280
School & Public Buildings	225	1,900	427,500
Restaurant	262	500	131,000
Trailer Park	25	150	3,750
Trucking	65	88	5,720
Wholesale	38	140	5,320
Miscellaneous*	1,346	36	48,456
Totals	4,880		1,026,780
		Say -	1,027,000 Lbs. /Wk.

*Miscellaneous includes such businesses as shoe stores, shoe repair, TV and radio repair, jewelry stores, service stations, photographers, etc.

The United States Department of Commerce publication--County and City Data Book-1967--indicates that in 1963 there were some 5,326 retail, wholesale and selected service establishments in Genesee County. This publication also indicates there were 3,381 like establishments in Flint, or 63.5% of the County total. To arrive at a reasonable estimate of the refuse produced by the establishments outside the City of Flint, the percentage of establishments might be used. However, it would appear more reasonable to use the relation of sales volume as this gives a much better indication of relative size. The County and City Data Book-1967 lists the total County sales for the aforementioned establishments as $986,372,000 for the year 1963, with the City of Flint businesses accounting for $695,200,000 of that total, or just over 70%. Since this appeared to be a more reasonable comparison, it was assumed that 70% of the commercial refuse generation comes from the City of Flint. The total generation from the entire County should then approximate

$$\frac{1{,}027{,}000 \times 100}{.70} = 1{,}467{,}000 \text{ pounds per week}$$

Determination on a pounds per capita per day basis for an estimated population of 455,000 for the County equals

$$\frac{1{,}467{,}000}{455{,}000 \times 7} = 0.46 \text{ pounds per capita per day}$$

From the field surveys made by the Engineers in checking the commercial and institution collections by both the public and private collectors, a physical analysis was estimated that is believed to be reliable. However, it should be pointed out that it was not possible to actually weigh and then segregate the refuse as was done in determining the physical analysis of the residential refuse. The estimated physical analysis is shown in Table IV-3, below, for the commercial and institutional refuse in the City of Flint. The Engineers are of the opinion this estimated analysis would be fairly representative of the entire County's commercial and institutional refuse.

TABLE IV-3

ESTIMATE OF PHYSICAL ANALYSIS OF REFUSE GENERATED BY COMMERCIAL AND INSTITUTIONAL ESTABLISHMENTS CITY OF FLINT AND GENESEE COUNTY, MICHIGAN

Classification	Percent
Garbage	24
Paper, Magazines, Cardboard	57
Plastics, Rubber, Leather	1
Rags	1
Lumber & Wood	2
Metal	6
Glass	6
Ash	3
Combustibles	85
Non-Combustibles	15

(c) Industrial Solid Waste Generation

The problem of industrial waste has been receiving increased attention in the Flint Metropolitan area, as it has throughout the country. A number of individual industries in the area have surveyed their refuse generation. As pointed out in Section I, the Chevrolet Flint Manufacturing Division of General Motors Corporation made a study of their waste disposal during a week in July, 1966, and a copy of their report has been made available to the Engineers. Also, in the early part of 1967, the Flint Industrial Waste and Pollution Control Committee sent questionnaires to a large number of industries in the area in an attempt to find out the amounts and kinds of waste they currently disposed of. Composite tabulations of these replies were made available to the Engineers. This survey was quite complete, as it requested information for each classification of solid waste, the disposal agency and the estimated quantity. Analysis of the survey indicated some misunderstanding in estimates of quantities and the disposal agencies utilized by industry. The Flint Industrial Waste and Pollution Control Committee continued its invaluable work of gathering additional data that was verified as correct early in 1968. Table IV-4, on page IV-18, has been developed from the tabulations of generation of the various classifications of industrial solid waste.

TABLE IV-4

INDUSTRIAL SOLID WASTE GENERATION GENESEE COUNTY, MICHIGAN

Classification	Quantity Generated Lbs. /Month	Quantity Disposed of Within County Lbs. /Month	Quantity Disposed of by Owner Lbs. /Month
Garbage	334,290	190,211	144,079
Cardboard, Paper, Etc.	6,985,121	6,985,121	-
Canvas, Rags, Etc.	2,142,597	2,142,597	-
Wood	5,784,348	5,784,348	-
Rubber & Gasket Material	544,920	544,920	-
Plastics	261,963	261,963	-
Oils	391,256	121,289	269,967
Thinners	307,835	307,835	-
Trimmings (Grass & Shrubs)	3,135	3,135	-
Slurries & Sludges	9,570,265	8,585,265	985,000
Ashes	11,527,064	11,527,064	-
Glass	146,629	146,629	-
Pavement, Concrete, Etc.	2,519,109	2,519,109	-
Dirt, Sand, Etc.	895,069	237,193	657,876
Floor Sweepings	315,196	315,196	-
Cans, Bands, Wires, Etc.	1,472,812	1,472,812	-
Chemicals	86,199	13,292	72,907*
Explosives	180	180	-
Total - Lbs. /Month	43,287,988	41,158,159	2,129,829
Total - Lbs. Combustibles Per Month (Slurries & Sludges Not Included)	16,755,465	16,341,419	414,046

*This Material is removed by a Contractor and taken to Detroit for disposition.

It should be pointed out that individual plants dispose of more than the 2,129,829 lbs. per month indicated in Table IV-4. One plant alone generates an average of 55,600,000 lbs. per month of core sand. Since there is and always has been a large demand for this material it was not considered as material disposed of as waste. Also, it was determined that the following classifications of the generated industrial solid wastes should be considered as requiring 100% disposal outside the individual plant even though at the present time the listed percentages are disposed of within the individual plants.

Classification	Present Percent Disposed of Within Individual Plants
Cardboard, Paper, Etc.	10.6
Canvas, Rags, Etc.	1.7
Wood	9.6
Ashes	9.3
Pavement, Concrete, Etc.	12.6
Floor Sweepings	62.1
Cans, Bands, Wires, Etc.	1.5

The total estimated generation of 41,158,159 lbs. per month that is disposed of outside the individual plant within the County on a per capita per day basis equals

$$\frac{41,158,159 \text{ lbs./month} \times 12 \text{ mo./yr.}}{455,000 \text{ est. pop.} \times 365 \text{ days/yr.}} = 2.97 \text{ lbs./cap./day}$$

If we use the total industrial generation from Table IV-4, the per capita per day generation for all industrial wastes becomes

$$\frac{43,287,988 \times 12}{455,000 \times 365} = 3.13 \text{ lbs./cap./day}$$

(d) Total Present Estimated Generation

All of the domestic or residential refuse, all of the commercial and institutional refuse, and the industrial portion constitute the major percentage of the total quantities of solid waste generated within the County. There are, however, other items that must be included in the total estimate. These are such items as tree trunks, large tree trimmings, dead animals, construction and demolition debris, and junk.

In the Appendix, on pages -ii- through -x-, is a copy of the Flint Recreation and Park Board Report - Solid Wood Waste of the City of Flint. This information source estimates 30,000,000 lbs. per year of wood waste generated from trees and bushes within the County.

The City of Flint Department of Public Works picks up dead animals within the City. The annual pick-up amounts to approximately 3,000 animals per year. The County also operates two small crematories for disposal of dead dogs; however, no records are maintained as to the number disposed of. Since there are normally more animals per family in rural areas than in the City, the Engineers estimated the County probably generates about 4,000 animals per year for a total of 7,000 animals per year. Assuming 40 pounds per animal, the estimated annual generation of dead animals equals 280,000 lbs. per year.

Demolition of buildings create relatively large quantities of solid waste since very little is salvaged today. Visits made by the Engineers to the private disposal sites and observation of demolition operations indicated that approximately 16 truck loads per day, Monday through Friday, of demolition material was being generated primarily in the City of Flint. Of this quantity, approximately 74% was lumber and 24% concrete, plaster, glass, etc. From the above quantity it is estimated that approximately 100,000,000 lbs. per year is lumber waste and 35,000,000 lbs. per year is inert wastes, such as concrete, plaster, glass, etc. Since urban renewal and expressway construction that produces this demolition material is almost entirely confined to the City of Flint, the above figures of demolition wastes are probably representative of the entire County.

Each spring the City of Flint Department of Public Works conducts a clean-up week. The junk that is generated is disposed of at the City's sanitary landfill sites. Therefore, this has been included in the totals previously discussed under (a) Domestic or Residential Refuse Generation, in this Section and should not be added a second time. The other contribution of junk is in abandoned and junked cars. Records of abandoned and junked cars are difficult to obtain; however, one operator in the City of Flint that picks up approximately ninety percent of the abandoned cars in the City did record over a 7-1/2 month period some 1,497 cars picked up. Eighty-five of those were either salvaged or sold at auction, leaving a balance of junked cars at 1,382 for that period. Assuming this represents ninety percent of Flint's abandoned and junked cars for the City, the total would approximate 1,535 for a like period. Since practically all abandonment of old cars occurs during the winter, and since the 7-1/2 month period reported above covered the fall and winter, the estimated number of 1,535 would probably suffice for the entire year. However, comparing this to the figure of 15,000 per year abandoned and junked cars for all of Wayne County that was supplied by the Michigan Secretary of State's office, it would appear high, based on a ratio of population by approximately 300 cars per year. Since records are not available, it is estimated the entire County probably generates about 3,000 junked cars per year. Apparently, these do not show up to any extent at any of the privately operated disposal sites in the County; therefore, we must assume the private salvaging operators are disposing of them outside the County. As pointed out in Section III, a supplemental study and report is being prepared on the disposal of junked and abandoned cars.

Recapitulating the estimated present total County generation from all sources of solid waste except the junked and abandoned cars is as follows, based on an estimated County population of 455,000:

Domestic or Residential Refuse	166,075,000 lbs./yr.
Commercial and Institutional Refuse	76,395,000 lbs./yr.
Industrial Solid Wastes*	493,898,000 lbs./yr.
Dead and Diseased Trees and Bushes	30,000,000 lbs./yr.
Demolition Wastes	135,000,000 lbs./yr.
Dead Animals	280,000 lbs./yr.
Estimated Year Total	901,648,000 lbs.

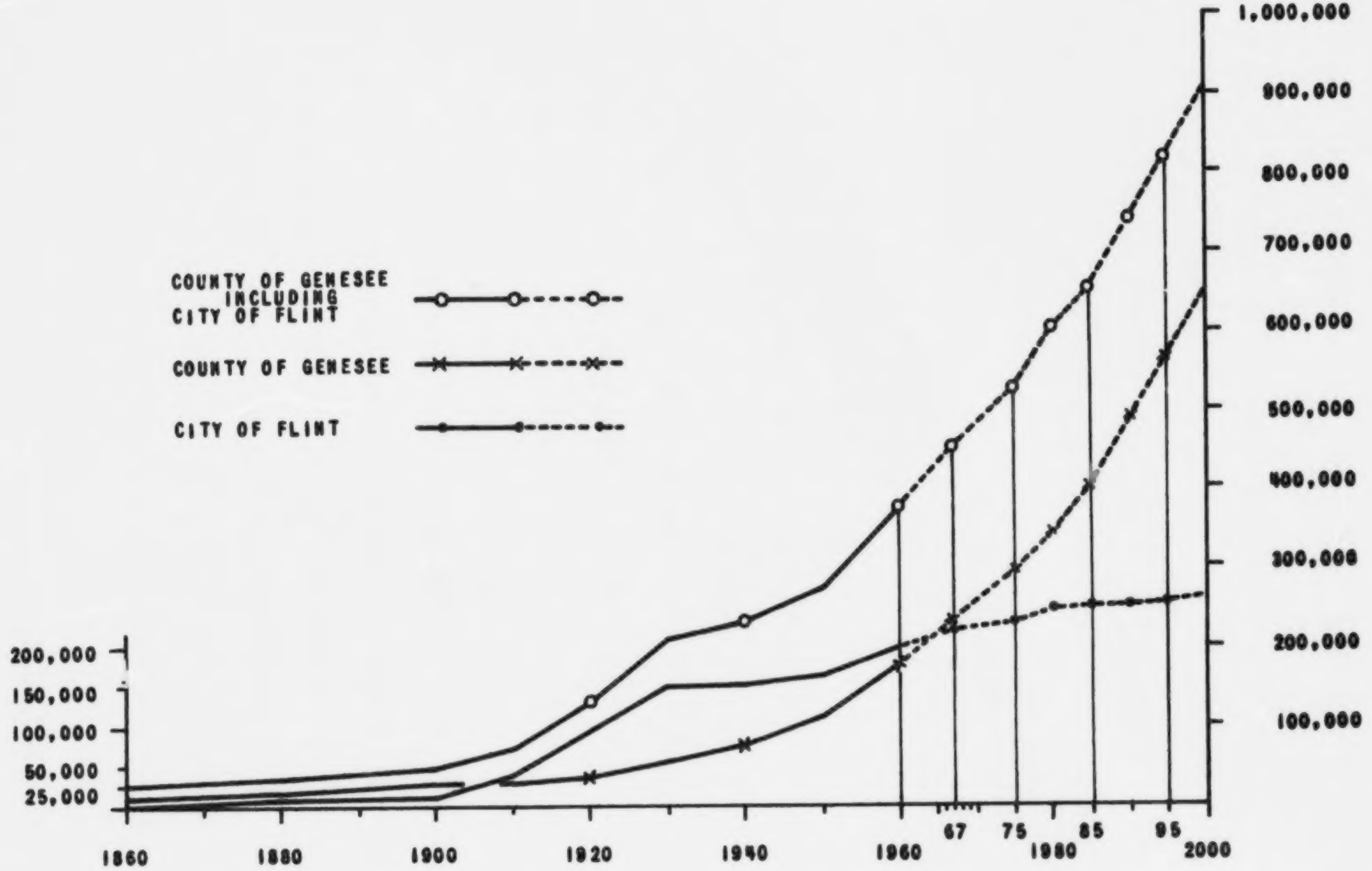
Based on generation per capita per day, the figure would be

$$\frac{\text{901,64,000 lbs./yr.}}{\text{455,000 est.pop. x 365 days/yr.}} = \text{5.43 lbs./cap./day}$$

2. Projected

Any projection of future refuse generation is made up of two factors: projected population, and a projection of the refuse generation per capita. A number of projections of the population of Genesee County and its subdivisions have been made by various authorities. Considering carefully all the projections by others that they have discovered, the Engineers reached the conclusion that it would be reasonable to expect the City of Flint to increase a little over 25% of its 1960 population of 196,940 by 1985, and about 30% by 1995. The remainder of the County, lying outside the city limits, is believed likely to double its 1960 population of 204,373 by 1985, and it appears probable that by 1995 there will have been an increase of over 175%, bringing the population to 2-3/4 times its 1960 value. Figure IV-5, on page IV-24, graphically illustrates these population projections.

*Using the industrial solid waste disposed of in the County outside the industrial plant.



POPULATION PROJECTION TO YEAR 2000

FIGURE IV-5

A study made by the Division of Environmental Engineering and Food Protection, Public Health Service, U.S. Department of Health, Education and Welfare, in 1963, indicated that the 1967 production of solid waste would approximate 4.65 lbs. per capita per day for the United States. The study projected to 1990 indicated the national average will then approximate 6.25 lbs. per capita per day.

Information just released on a recent study by Combustion Engineering, Inc. conducted for the Public Health Service indicates approximately 1,380,000,000 pounds of residential, commercial and industrial wastes are generated in the United States each day, or 5.1 pounds per capita per day.* The report further indicates that 1,000,000,000 pounds must be collected and disposed of daily by municipal and private facilities. The balance of 380,000,000 pounds is disposed of by industry within its own deposit areas. A decade ago the national average was about 2.5 pounds per capita per day. The previous national estimate made in 1963 for the 1967 production of 4.65 pounds per capita per day is about 10% lower than this latest national estimate.

The estimated total solid waste generation of 5.43 pounds per capita per day for Genesee County is approximately 6.5% higher than the latest available national figure, which appears reasonable when we consider the large amount of manufacturing in Genesee County.

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*Solid Waste Management, Refuse Removal Journal, p. 22, March, 1968, RRJ Publishing Corp., New York.

The Engineer is of the opinion that only a decade ago the estimate of approximately 2.5 pounds per capita per day generation was probably low. His reason for such a statement is based upon the fact that even today record keeping regarding solid wastes is practiced by only a small number of municipalities--ten years ago the number maintaining records was even smaller. Such records were usually for the municipal residential portion of the solid wastes generated. Therefore, estimates of all the other producers of solid waste had to be made with little factual information, in the Engineer's opinion. His own experience in endeavoring to gather reliable data of present generation is a case in point. Only in the very recent past has there been any concerted effort to arrive at realistic figures. For this reason the projections of generation of refuse that are made on the following pages for the various categories will certainly not follow what appears on the surface to be a 100 percent increase in the past ten years. It is the Engineer's opinion that the recent publicity given to this problem of solid waste will, in the future, result in much better record keeping--this in turn will indicate that the country is not doubling its solid waste on a per capita basis in ten years.

The estimated present domestic refuse generation of 1.00 lb. per capita per day is low when compared to national averages. Taking this into account, the Engineers estimate this portion of the County's solid waste will increase to 1.54 by 1985 and to 1.84 by 1995 on a pounds per capita per day basis.

Due to the practice of utilizing many private collectors to take care of the commercial refuse reliable figures on a national basis are not available for this portion of solid waste generation. The 1965 American Public Works Association survey of seven cities generation of combined commercial and industrial refuse resulted in a median generation of 2.0 lbs. per capita per day. The Engineers' 1966 survey of St. Paul, Minnesota generation of combined commercial and industrial refuse was only slightly higher, and visual observation indicated the commercial portion was approximately 50% of the combined refuse. However, since these surveys were made only in municipalities and not on a county-wide basis, their meaning is not too significant. The Engineers are of the opinion that commercial refuse generation will not increase at the same rate as will the domestic portion, and have estimated that the rate by 1985 will be about 0.64 and by 1995 about 0.75 lbs. per capita per day.

The Genesee County industrial plants present generation of solid waste amounts to 2.97 lbs. per capita per day. The Engineers believe that the contribution of industrial wastes will not increase at the rate of increase estimated for domestic refuse, as it is their opinion industry will be forced to find ways to utilize the waste material should the amount increase very much over the present figure. Therefore, a more modest increase from 2.97 lbs. per capita per day to 3.29 by 1985 and to 3.47 lbs. by 1995 has been estimated.

There will probably be a small increase in the solid waste generation caused by the removal of dead, injured and diseased trees until the Dutch Elm desease has claimed most of the elms. After that, this portion of solid waste generation will probably decrease. The estimate for 1985 is 0.28 pounds per capita per day and 0.32 by 1995.

As the population increases and the urban renewal program slacks off, the Engineers feel that the total generation of demolition material on a per capita per day basis may decrease slightly. However, because of the estimated rate of increase of population, the actual tonnage will continue to rise through the foreseeable future. The estimate for 1985 is given as 0.62 pounds per capita per day and 0.51 for 1995.

It is estimated that the amount of dead animals in the County to be disposed of will remain at a steady rate of about 0.0017 pounds per capita per day; or, in other words, the animal population will probably increase at the same rate of growth as the population.

Table IV-5, on the following page, lists the projections of the various classifications of generation. This table also indicates the total pounds per capita per day, along with total estimated tons generated per day, based on the population projections for 1985 and 1995. This table includes the total estimated solid waste generated except that part of industry's generation that does not leave the plants.

TABLE IV-5

PROJECTED REFUSE GENERATION BY GENESEE COUNTY, MICHIGAN

		Present	1985	1995
Population		455,000	655,000	820,000
1.	Domestic or Residential Refuse, lbs. /capita/day	1.00	1.54	1.84
2.	Commercial & Institutional Refuse, lbs. /capita/day	0.46	0.64	0.75
3.	Industrial Refuse* lbs. /capita/day	2.97	3.29	3.47
4.	Wood Refuse-Trees & Bushes lbs. /capita/day	0.18	0.28	0.32
5.	Demolition Material lbs. /capita/day	0.81	0.62	0.51
6.	Dead Animals lbs. /capita/day	0.0017	0.0017	0.0017
7.	Total Refuse* lbs. /capita/day	5.4317	6.3717	6.8917
8.	Total Refuse* tons/day	1,236	2,087	2,826

*Does not include industrial refuse disposed by Owner either within the industrial plant or outside the County.

B. COLLECTION PRACTICES

1. Domestic or Residential

Since late in 1965, the City of Flint, through the Department of Public Works, has collected combined refuse (rubbish as well as garbage) from the residences throughout the City. Residents are required to use ten and fifteen gallon standard containers, and to place the filled containers at the curb on collection days. Paper and yard debris may be put in cardboard boxes or plastic bags, and coal ashes in metal baskets. A copy of the City's Waste Collection Services can be found on pages -xi- and -xii- in the Appendix. There is an annual "spring clean-up" week during which bulky items are collected. Municipal buildings and hospitals have recently been provided with one and two cubic yard containers to speed up and simplify the collection of the large amounts of refuse these institutions generate.

As pointed out in Section I, the Flint Public Works Department operates thirty-two compactor trucks for the collection of this refuse. Thirty of these range in capacity from nine to sixteen cubic yards. In addition, it has recently acquired three new Diesel powered trucks with twenty cubic yard capacity. There are also two open trucks for special pick-ups and miscellaneous service. All of these trucks, as well as the three cars used by the Supervisor and his assistants, are purchased by the City and made available to the Department on an hourly lease basis, which covers fuel and maintenance while the capital costs are covered by the General Funds of the City.

The personnel of the Flint Department of Public Works concerned with the collection phase of its operation consists of a Supervisor and two assistants and fifty-six full-time collectors. Four additional collectors are employed on a seasonal basis. The total annual budget for the collection of refuse by the City Administration is a little over half a million dollars.

In that part of Genesee County outside the City of Flint, there are some thirty separate governmental units that may be concerned with the collection and disposal of refuse. As discussed in Section I, the Genesee County Metropolitan Planning Commission sent questionnaires to each of these local governmental units in an effort to determine their practices in the collection and disposal of refuse. A copy of the questionnaire is on pages -xiii- and -xiv- in the Appendix. Replies were received from the eighteen townships, the seven cities and five villages.

The Cities of Davison, Fenton, Mt. Morris and Swartz Creek reported they each had or were making agreements with private contractors for the collection and disposal of combined refuse. Costs of the service ranged from $10.80 to $15.00 per year for each resident and commercial establishment for weekly pick-up. Each community was providing at least one pick-up for their annual clean-up week campaign. The Cities of Mt. Morris and Swartz Creek have both a spring and fall clean-up week.

The City of Clio reported a private contractor picked up the garbage but that each individual householder was responsible for disposal of the rubbish. The cost to the City for the garbage pick-up was $9,582 for the year and this was paid from the General Fund.

The City of Flushing reported a private contractor picked up all the refuse and disposed of it at the McKinley Road dump in Montrose Township. Average cost was $10.80 per year per household paid for from General Fund.

The City of Grand Blanc estimated the refuse picked up by private contractor at 30 tons per week, which certainly appears to be quite high. The cost of the service was $18 per year per household. Payment to the contractor was made by the householder.

A survey made by the Michigan Municipal League in December, 1963 indicated that only the City of Flint in Genesee County provided municipal services in the collection of refuse. However, the survey revealed that the two small villages of Otisville and Otter Lake provided a publicly operated refuse pick-up service for the residents. Otisville estimated their refuse at 3 tons per week and collection and disposal costs of $10 per week. Otter Lake estimated nine to ten cubic yards of refuse per week collected and disposed of at a cost of $8. All other villages reported that collections were made by private contractors or the individual home owner disposed of his own refuse. The Village of Montrose bills each home owner $1 per month and pays the private hauler. Costs of service in the other two villages of Gaines and Goodrich are $24 and $18 per year per resident, respectively.

The Townships of Burton, Flint, Genesee, Grand Blanc and Mt. Morris reported each had an agreement with private contractors for the collection and disposal of mixed refuse. Costs ranged from approximately $6.50 per year per household to slightly over $15 per year per household. The higher costs included disposal of all garbage and refuse including papers and cardboard. The lower costs excluded paper, cardboard and combustible items that could be readily burned. All but one of the agreements required the contractor to dispose of the refuse outside the township, and the one that did not require this stated that the disposal location was in another township.

The Township of Davison reported a private hauler presently collected and disposed of the residents' refuse and that the cost of $0.62 per month per stop was paid for from the General Fund. The Township of Fenton reported individuals had contracts with private haulers and that the township paid from the General Fund for individuals to use a private dump during clean-up campaign.

None of the Townships of Argentine, Atlas, Clayton, Flushing, Forest, Gaines, Montrose, Mundy, Richfield, Thetford and Vienna reported having actual township agreements with a private contractor. However, they all reported that private contractors handled the mixed refuse collection and disposal in their townships. The normal practice was for the residents to arrange with the contractors for their individual pick-up of garbage and refuse. Costs to the individual resident range from $6 per year for just garbage pick-up to $26 per year for combined refuse.

It appears that the independent contractors will provide relatively uniform charges within a township but since density of population and mileage has a definite bearing on their costs, the charges are not uniform between the townships. However, it would appear that those townships that have agreements with the private contractors are obtaining the service at a lower cost per household than are those not having township agreements, but rather having the householder arrange for his own collection.

Most of the replies to the survey of the municipalities and townships within Genesee County did not indicate dissatisfaction with the services of the private collectors. Many, however, did express the fear that the actual disposal by the contractor might be stopped, which would adversely affect them. Apparently, the municipal and township officials within the County are aware of the fact that the present disposal methods used--the dumps and the "teepee"burners--will not be permitted to operate much longer.

2. Commercial

The City of Flint Department of Public Works collects refuse from small commercial establishments throughout the City. As previously discussed, small commercial and institutional pick-ups by the City amounts to between 50,000 pounds per week and 75,000 pounds per week, or between 4.9% and 7.3% of the total estimated generation in the City. Private collectors pick-up the majority of the estimated generation except that portion presently being incinerated in the private commercial incinerators. Outside the City of Flint all commercial refuse, except that being disposed of by the individual proprietor, is collected by the private haulers.

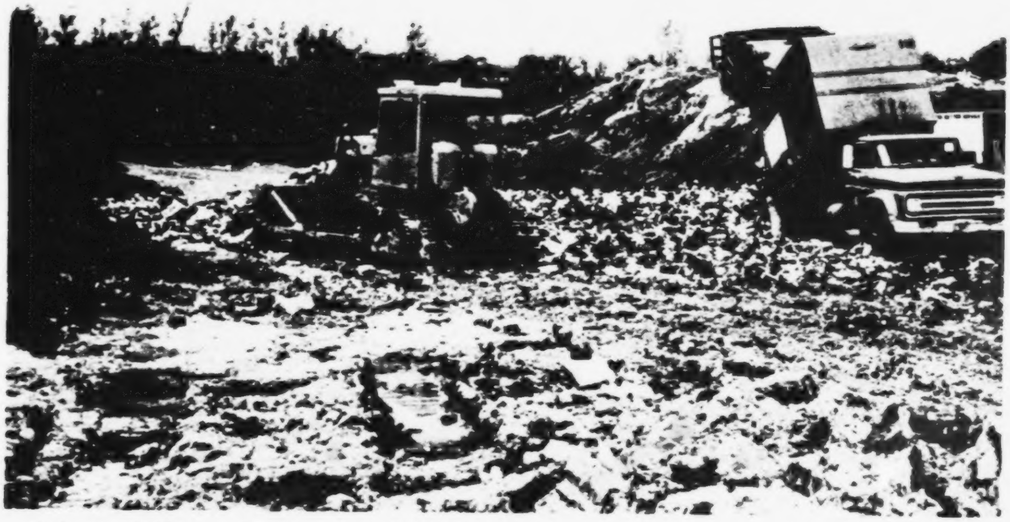
3. Industrial

The private contractors with very few exceptions collect the industrial solid wastes. A particular industrial plant may provide the necessary equipment to transport its individual wastes away from the plant, but this is the exception and not the usual method.

C. DISPOSAL PRACTICES

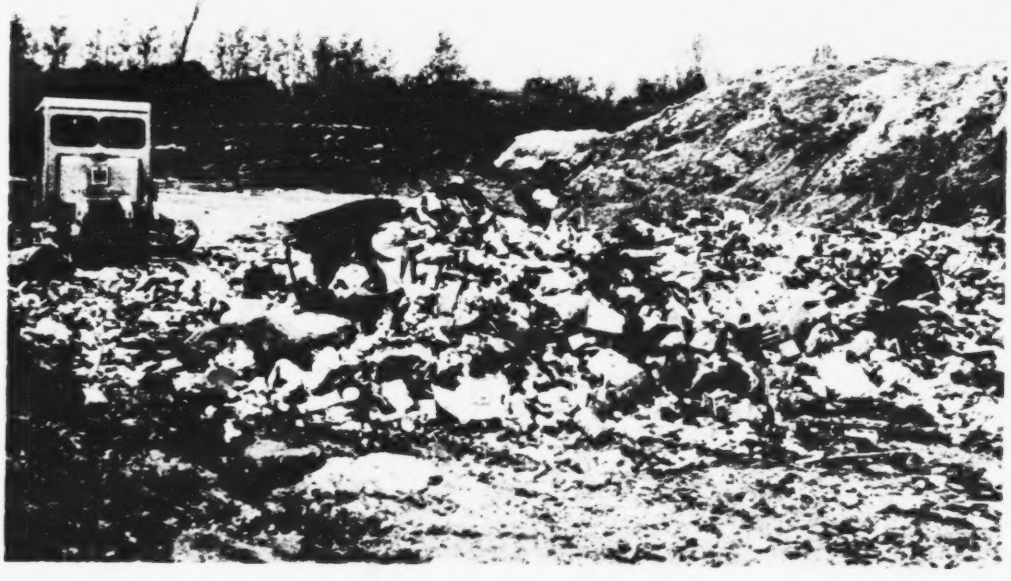
1. City of Flint

Refuse from householders, small commercial and institutional establishments picked up by the City Department of Public Works is disposed of at one of two landfill operations. See Figures IV-6 and IV-7, on page IV-36. The North End site is located north of the Water Plant on Park property in the northeast section of the City. The other site is at the Bishop Airport southwest of Flint. One attendant and three equipment operators are employed at each site by the City Department of Public Works, and the equipment used in the disposal operations consists of four bulldozers, a shovel, a tractor-drawn scraper, and two pick-up trucks. All of this equipment is provided by the City of Flint to the Public Works Department on the same lease arrangement as the collection trucks.



View of City of Flint Landfill Operation.

FIGURE IV-6



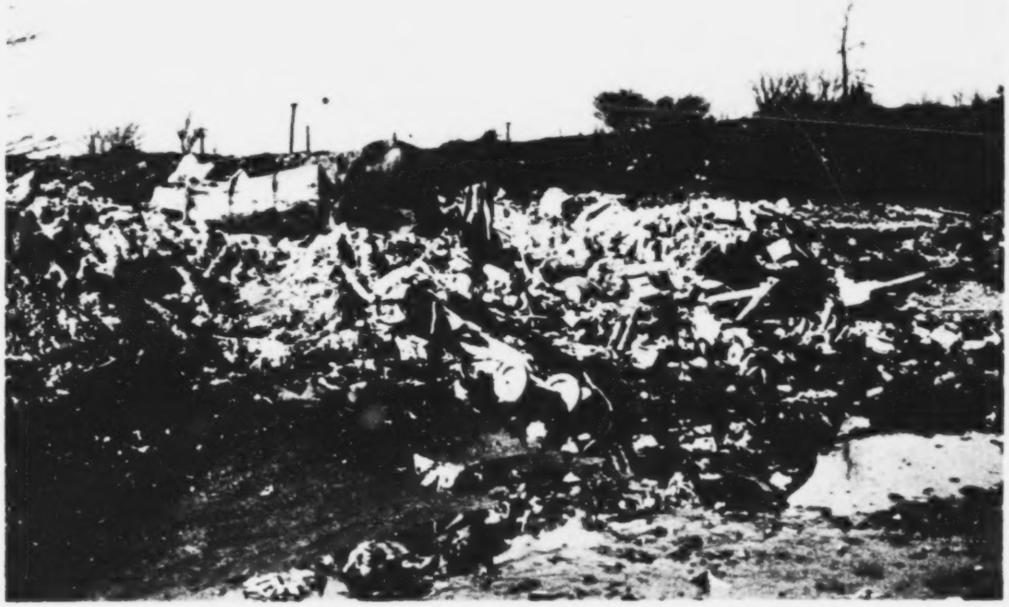
View of City of Flint Landfill Operation.

FIGURE IV-7

Both operations are sanitary landfills and have been licensed by the Michigan Department of Public Health as required by the Solid Waste Disposal Act 87 of the Public Acts of 1965. The City has made strenuous efforts to comply with the requirements of this Act in the present operation at both sites. Present requirements of operation will reduce the capacity of both of these locations. It is estimated that within the next five to six years the City will be forced to find another site or sites.

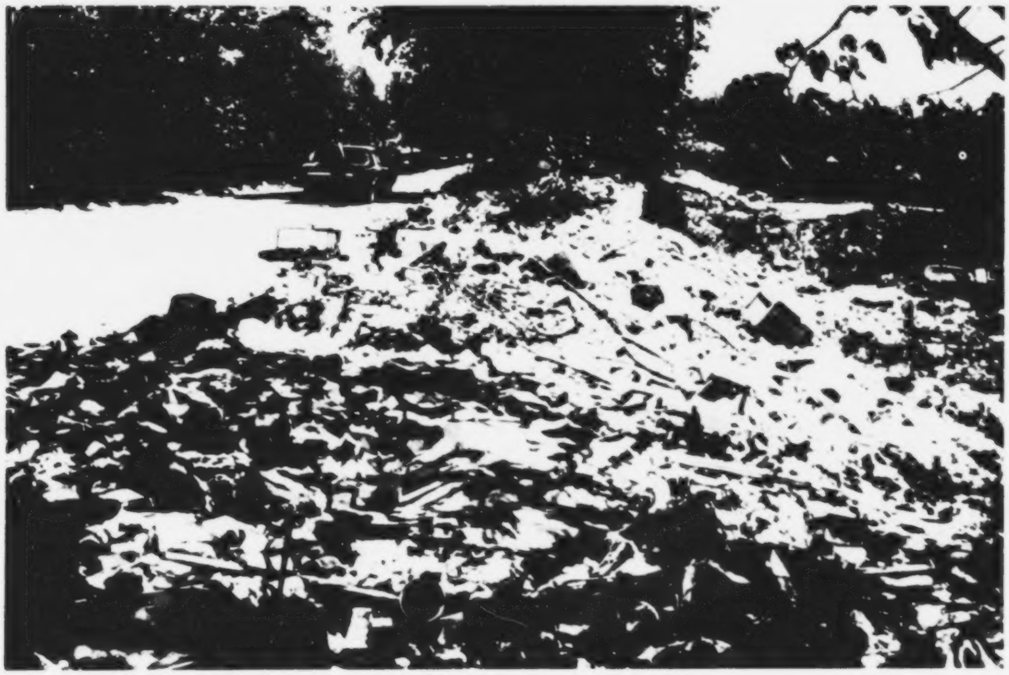
2. Remainder of County

There are a number of dumps, operated either by certain of the private refuse haulers or by commercial operators for profit, scattered throughout Genesee County (see Figure IV-14, on page IV-42 , for locations). The Engineers attempted to inspect all of these but were informed that many of them were no longer in operation. At others they were firmly denied admission. The general impression with which they were left was of a metropolitan area in which the available disposal sites were rapidly disappearing. Most of those sites which they were able to visit appeared to be nothing but open dumps. See Figures IV-8 and IV- 10 , on pages IV-38 and IV-39. Although those sites presently operating have been licensed in the past, it is extremely doubtful if any will have complied with the stringent rules of the present Act by the May 31, 1968 dead line established by the Michigan Department of Health. It is the Engineers' opinion that if all of the present sites were operated on a satisfactory sanitary landfill basis,



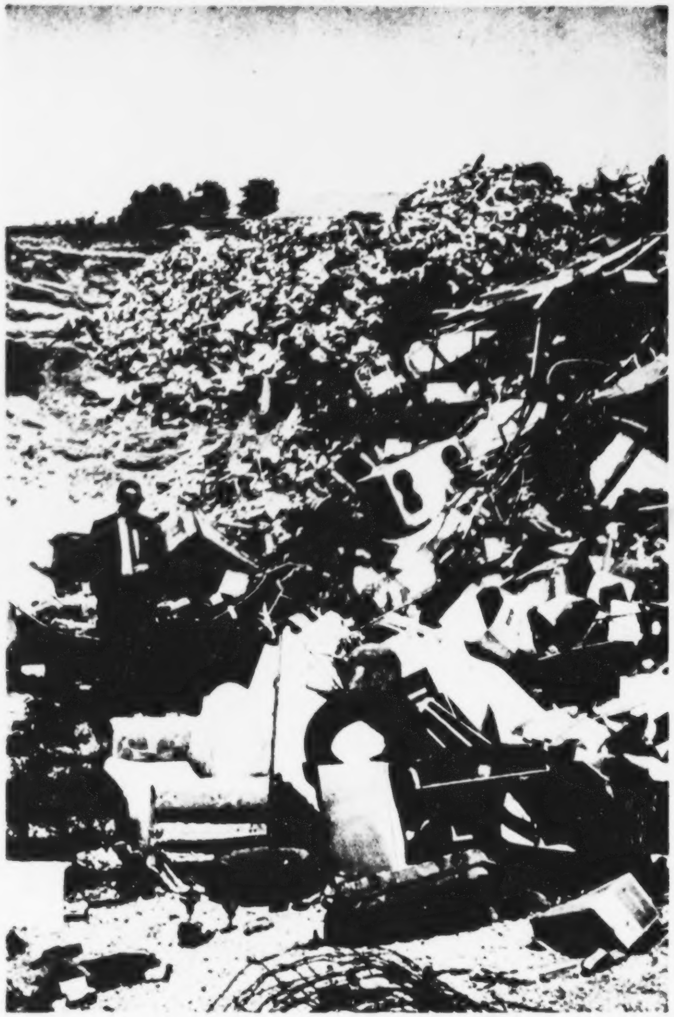
View of an uncontrolled dumping operation.

FIGURE IV-8



Roadside dumping along a county road in rural area.

FIGURE IV-9



Typical uncontrolled refuse dumping. Although refuse is covered with fill, no compaction is used to minimize land usage.

FIGURE IV-10

Roadside dumping in drainage ditches.

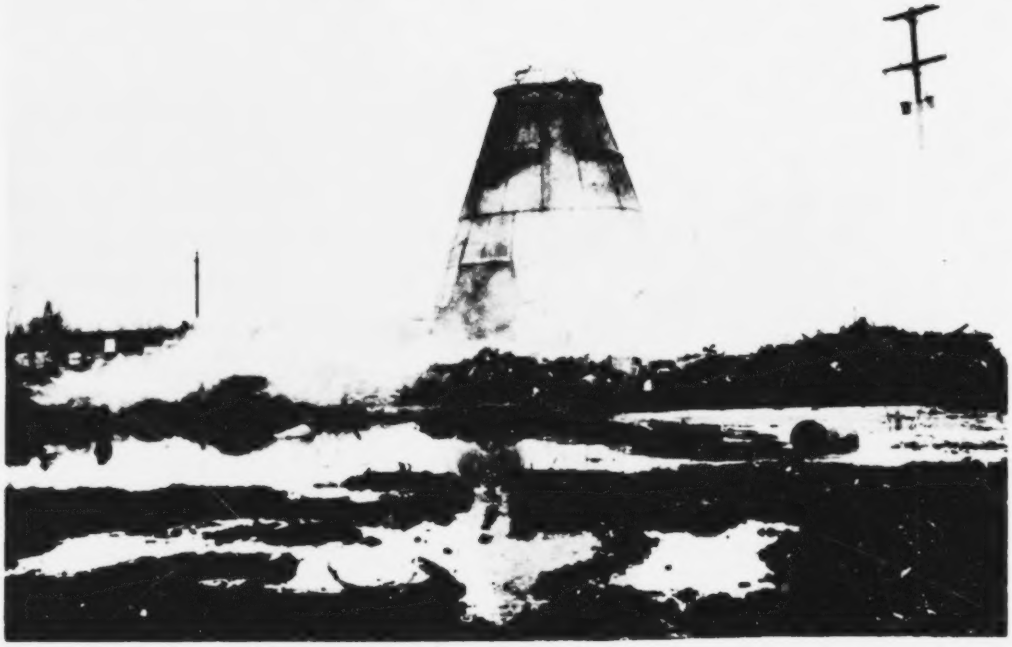
FIGURE IV-11

four or five years' operation would completely fill the available areas. The discussions the Engineers had with some of the private collectors as well as with a few operators of the dumps revealed that most were well aware that if landfill is to be utilized as the primary method of disposal in the future more land will be needed.

All of the private contractors servicing the municipalities and townships in Genesee County utilize these dumps. As was previously pointed out, some have the so-called "teepee" burners which they use in an effort to reduce the volume of material.

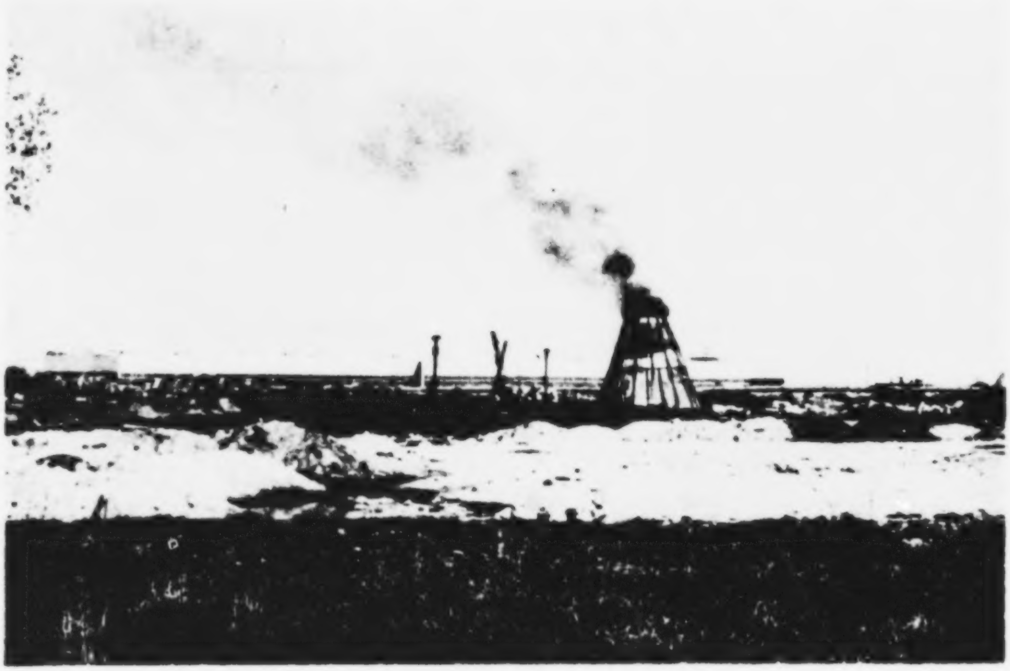
Not one of these so-called "teepee" burners would pass even a very lax air pollution ordinance, nor could they be classed as an incinerator by even the strongest stretching of the imagination. They are no more than large, inefficient backyard trash burners that may confine the actual flames to the inside of the cone. A glance at Figures IV-12 and IV-13, on page IV-41, is typical of their operation.

In addition to the various dumps, some of the County's citizens have made it a practice to dump their refuse alongside a convenient County road (see Figures IV-9 and IV-11, on pages IV-38 and IV-39.



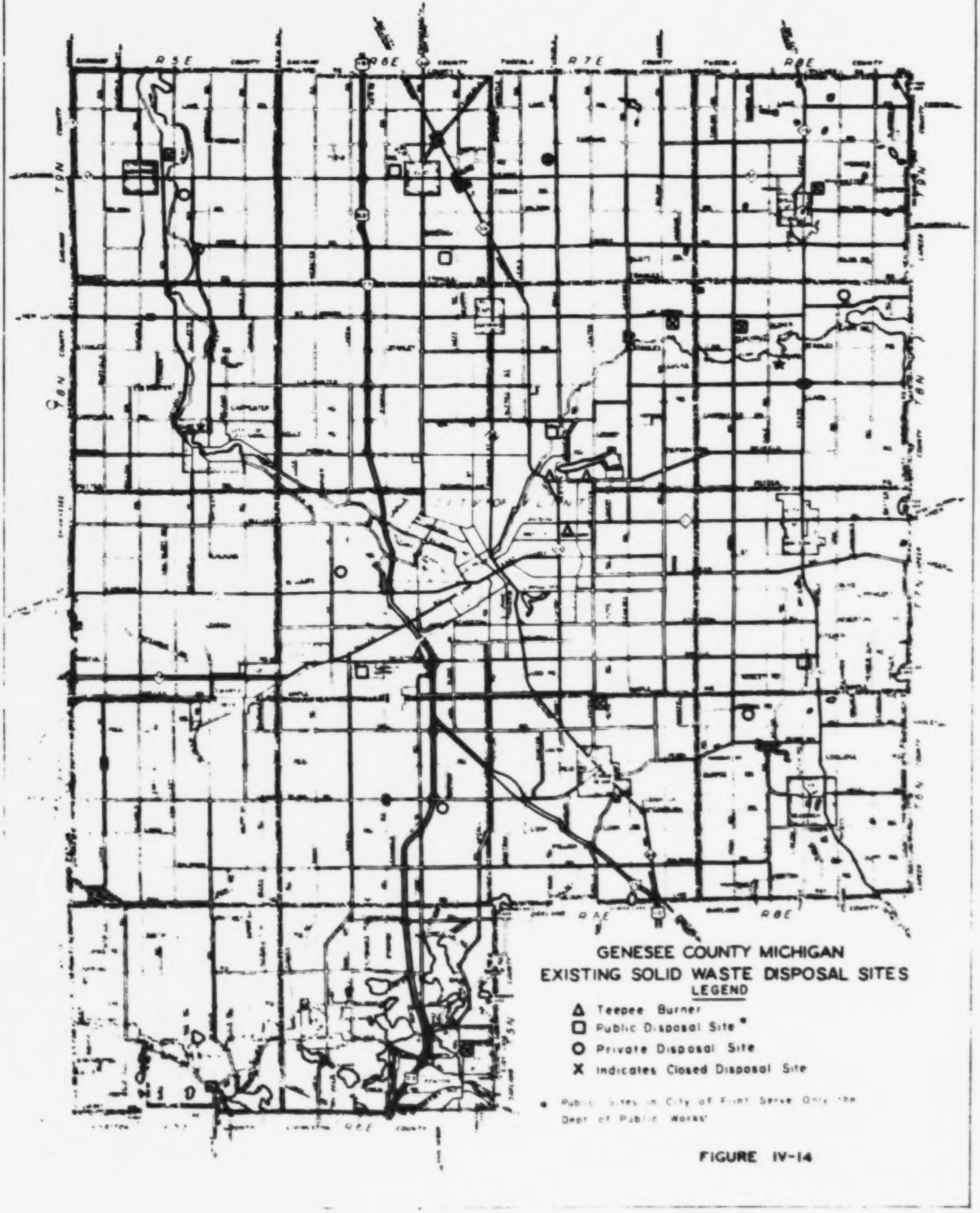
Private Incinerator used for mixed refuse. Note partially incinerated residue still burning.

FIGURE IV-12



Privately owned and operated Incinerator creating air pollution nuisance.

FIGURE IV-13


R5E
R6E
R7E
R8E
T9N
T8N
T7N
T6N
T5N
CITY OF FLINT
LEGEND
△ Teepee Burner
☐ Public Disposal Site*
○ Private Disposal Site
X Indicates Closed Disposal Site
* Public Sites in City of Flint Serve Only the Dept. of Public Works

GENESEE COUNTY MICHIGAN
EXISTING SOLID WASTE DISPOSAL SITES

FIGURE IV-14

V. TENTATIVE PROGRAMS FOR GENESEE COUNTY

Before embarking on a description of possible refuse management programs which might be adopted in the County of Genesee, the Engineers wish to emphasize the importance of keeping complete and accurate records. The forecasts of future refuse generation on which these programs are based are the result of careful study and analysis, and are believed to be as reliable as any similar prediction can hope to be. They are, however, founded on a number of factors whose certainty leaves much to be desired. For one thing, predictions of future population are, at best, hazardous. As an example, a study made for the Flint Planning Commission* goes into this matter very carefully for the Flint Urbanized Area. Their research indicates that the only supportable projection is a range of populations within which the actual figure may be expected to fall. The report gives such ranges for 1960, 1970, and 1980. The figure given by the U.S. 1960 Census hits close to the center of the range they give. Another set of population projections has been prepared by the Michigan Department of Commerce.** Using these as a basis for an estimate of the future population of the Flint Urbanized Area gives a figure for 1970 which falls very near the center of the range given in the Planning Commission report. For 1980, however, the figure derived from the Department of Commerce data falls completely outside the range given in the Planning Commission study, in the direction of higher population. Part of this difference may be due to varying opinions of what will constitute the Flint Urbanized Area in these two future years (Figure V-1, on page V-3, compares the 1958 urbanized area shown in the Planning Commission report with those given in the 1950 and 1960 U.S. Censuses), but a substantial part undoubtedly reflects the uncertainty which inevitably veils the future.

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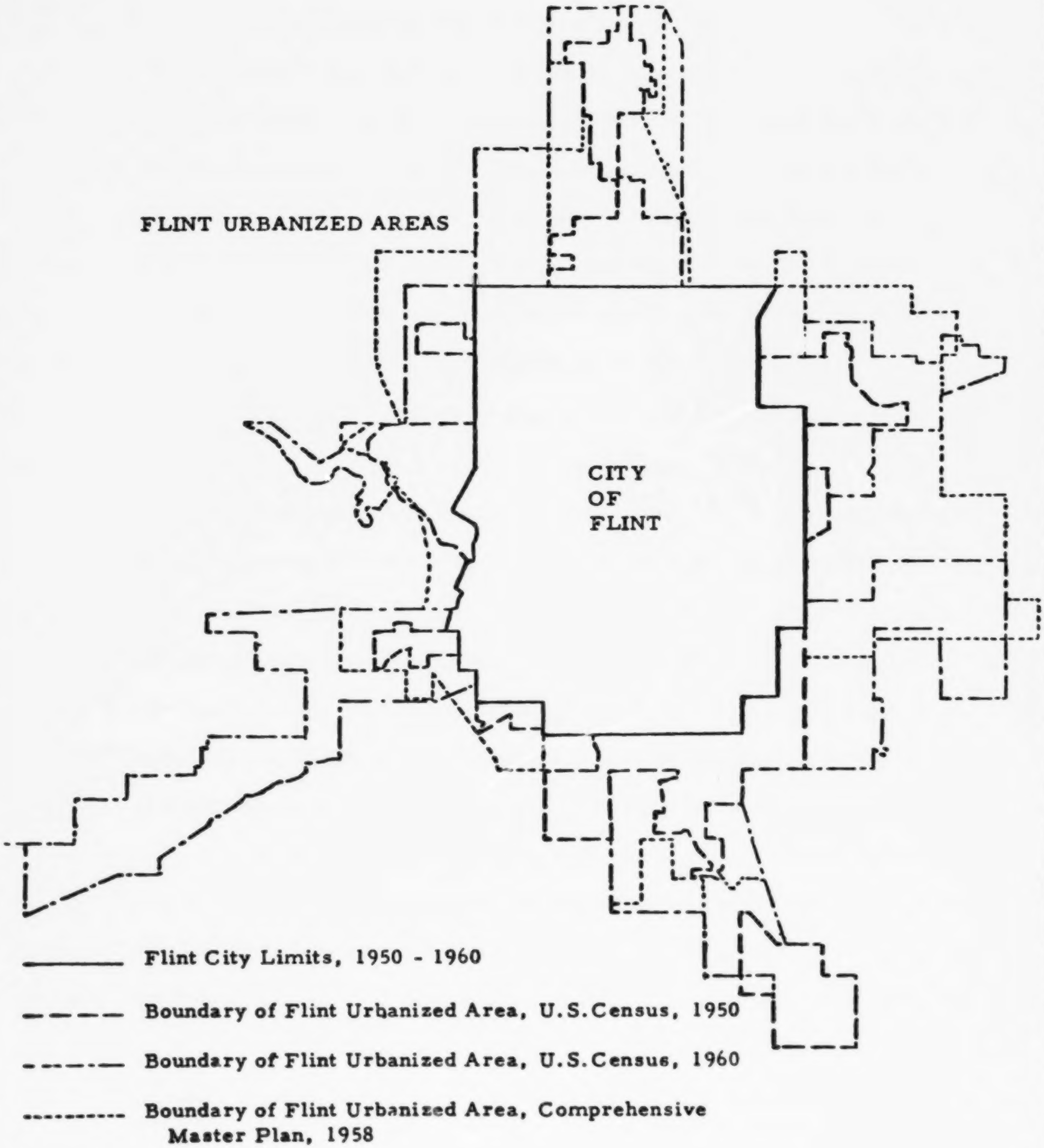
* Ladislas Segoe & Associates: Comprehensive Master Plan, at Flint, Michigan, 1960.

** Preliminary Population Projections for Small Areas in Michigan, Working Paper No. 9, State Resource Planning Program.

The case is similar with the other elements which go to make up the final estimate. The overwhelming probability is that refuse generation per capita will increase, but how fast and how far it is impossible to say with any confidence. Even the estimates of present refuse generation rely on certain assumptions and extrapolations from limited data. Furthermore, technological changes at which we cannot even guess may radically alter the composition of the refuse collected from households, from businesses, or from industrial establishments. All these uncertainties make any future projection, at best, an estimate of probable trends. If exact records of the tonnage of refuse actually disposed of are kept regularly, as a matter of routine, the current trends can be compared with those that were projected, and the program that may be adopted can be periodically updated accordingly. Without such consistent records, those charged with responsibility for planning the disposal operation will be continually working in the dark.

FIGURE V-1


FLINT URBANIZED AREAS
CITY OF FLINT
—— Flint City Limits, 1950 - 1960
– – – – Boundary of Flint Urbanized Area, U.S.Census, 1950
– - – - – Boundary of Flint Urbanized Area, U.S.Census, 1960
.... Boundary of Flint Urbanized Area, Comprehensive Master Plan, 1958

A. COLLECTION

Collection will be considered separately from disposal because, in Genesee County, the situation is quite different regarding these two aspects of the refuse management problem. While no disposal operation now being conducted in Genesee County conforms fully to the requirements of the present state regulations, collection services seem, on the whole, to be adequate. The requirements for disposal do not vary from community to community, being far more dependent on the type of refuse which is to be handled. Collection services, on the other hand, are primarily determined by the type of community they serve.

1. Organization

With any quasi-governmental agency, and still more with one directly operated by an arm of the local government, the question of equality of treatment and charges for the service affect each individual resident. The determination of what constitutes fair and equal treatment in a field with as many variables as that of refuse collection usually varies from community to community. According to the previously mentioned survey of the collection and disposal of refuse by the various governmental units in Genesee County, charges made by the several private contractors providing this service vary over a range of almost four to one. This may well be a reasonable reflection of the variation in costs. As Arora and Bunker have pointed out*, the time required for travel between stops, other things being equal, varies as the square-root of the total area over which they are dispersed. From this it is obvious that costs will be much higher for collection from a sparsely settled area than from a congested urban section.

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*S. R. Arora and W. R. Bunker: Examining Costs in Solid Waste Disposal, Public Works, October, 1967.

Point of pick-up is another variable. Although all of the contracts submitted in the survey previously mentioned called for picking up refuse at the curb, except in some commercial areas where alleys are provided, more than half of them contained a clause specifically authorizing the contractor to make special arrangements with individual householders for pick-up from other points. This is a kind of flexibility which is very difficult for any quasi-governmental agency to provide. Any attempt to do so would tend to provoke resentment on the part of some taxpayers.

As pointed out in Section II, page II-13, frequency of collection for 90 percent of the cities surveyed was either once or twice per week for domestic refuse. However, commercial establishments usually generate refuse at too rapid a rate for only once a week, or even twice a week, collections. Some commercial establishments may even require daily collection service. Residential service should be once a week for all householders in Genesee County. Service for commercial establishments should be on a more frequent basis as required by the particular establishment.

Allocating costs on an equitable basis between these two classes of service can be a difficult problem.

The receptacles for refuse storage and collection cause much concern as discussed in Section II, page II-11. Examination of the survey questionnaires from governmental units in Genesee County reveal quite wide variations in requirements for receptacles. Visual observation by the Engineers indicated a uniform requirement for residential users throughout the County would probably improve the appearance of both urban and rural areas. The practice of requiring the householder to use too small a container (10 to 15 gallon capacity) with the added requirement of bundling and tying of newspapers and magazines results in unsightly paper and debris being deposited or blown about the streets and yards. The use of bushel baskets and cartons also tends to increase the amount of debris that blows away from the collection point. As pointed out in Section II, the trend is toward standardization utilizing metal containers with tight-fitting lids having a volume of 30 to 32 gallons and weighing less than 100 lbs. when full.

It is the Engineers' opinion that all municipalities and township governments should, by ordinance, establish a uniform refuse container size of 30 to 32 gallons, constructed of either galvanized metal or plastic material, suitable for temperatures as low as minus 30 F. Each container should be equipped with metal handles and have a tight-fitting lid of the same material as the container. Each resident should be permitted a maximum of four such containers for once a week collection, and the maximum filled weight should not exceed 75 lbs. per container. Such weight can be readily handled by the collection personnel.

All tree and bush trimming refuse should be tied into bundles of not over 50 pounds in weight nor longer than 4 feet so that one can can easily handle the bundle.

The Engineers also recommend that all governmental units require the use of enclosed, drip-proof type collector trucks for collection of mixed refuse. The enclosed, drip-proof collector truck of the compactor type is becoming the standard, as pointed out in Section II. Since the City of Flint presently utilizes this type of equipment and most if not all of the private collectors have such equipment, this should present no problem in enforcement. Demolition material and large bulky items that are normally picked-up in the "clean-up week" campaigns can be transported in open trucks if they are not filled to the point where wind and normal vibration may cause loss of some of the load.

To further improve the general sanitary and health conditions throughout the County there should be a uniform policy established for the collection of dead animals. The City of Flint presently collects dead animals within the City. The County collects dead dogs when called upon to do so, but there is presently no agency set up to collect other dead animals in the County outside of Flint. This should be done, and the County is probably the most logical governmental unit to provide this service.

The County should also establish a uniform policy for removal of dead and diseased trees. The Forestry Department of the City of Flint provides this service for trees in the parks and streets within the City. The advent of Dutch Elm disease has created a problem that must be met with in a constructive manner. Safety alone dictates that these dead and dying trees be removed.

The collection of industrial wastes is presently being handled by the private contractors. Here again, special problems are encountered in both frequency of collection and types of material handled. Industry has not indicated the present methods of collection should be changed.

None of the questionnaires received from the various governmental units in Genesee County expressed dissatisfaction with the private collectors performing the collection service in their community. Only a very few of the commercial questionnaires in the City of Flint contained any adverse comments regarding the collection service, and those few were basically aimed at the requirements regarding refuse containers of the City. No one expressed a desire for a basic change in the collection service.

Since there are a number of private businesses engaged in the collection of refuse in Genesee County, an attempt to set up a County-wide collection authority under governmental auspices is sure to raise the question, in some quarters, of governmental competition with private industry. If these private contractors are forced out of business by such an authority, there is always the question of the loss of taxes to consider, as an additional cost factor in the equation.

Finally, as the agencies now performing the function of refuse collection seem to be doing a satisfactory job, it is doubtful that a County-wide authority for the collection of all solid wastes could effect any substantial improvement in either service or costs.

For all these reasons, the Engineers recommend that refuse collection in Genesee County be left in the hands of those agencies now performing this service for the time being. As the outlying parts of the County become more urbanized, and the distribution of population, commerce, and industry become more uniform throughout the area, it may prove desirable to move in the direction of a unified collection system, and steps along this line can be taken at that time. Many of the contractors now collecting refuse in Genesee County, of course, also operate their own disposal facilities. This aspect of their operations will be discussed in the section on disposal which follows.

B. DISPOSAL

1. General

As previously discussed, disposal of the solid wastes generated in Genesee County is presently accomplished by utilizing sanitary landfills, as done by the City of Flint, with private landfills and "teepee" burners taking care of the balance of the County and industry. None of the disposal sites has sufficient capacity to handle the estimated future generation of refuse for more than about six years.

To solve the problem of disposal two courses of action are open. The first is to continue with the present type of operation, in which the City of Flint takes care of the disposal of its householders and small commercial establishments refuse, and private contractors take care of the disposal of the rest of the solid waste generated within the City of Flint as well as the rest of the County. As more land is required for disposal, the City of Flint and the private agencies would have to acquire such land or cease their operation.

The second course of action would be to create a County-wide disposal agency. Act No. 342 of the Michigan Public Acts of 1939 authorized the board of supervisors of a county to establish a county agency for the collection and/or disposal of garbage and/or rubbish, along with authorization to establish water and sewage disposal systems. The county agency can be either the board of county road commissioners or the drain commissioner, as determined by resolution of the county board of supervisors. If the county's population exceeds 1,000,000, the board of supervisors may designate, in addition to the two above, the board of public works of the county as the agency.

It is the Engineers' opinion a county agency for disposal is the only course of action that can be recommended. Creation of such an agency does not mean that private contractors should not be permitted to operate disposal facilities, providing there is compliance with the State regulations. For each of the various private firms now operating disposal facilities to upgrade their operations to comply with those regulations would require expenditures of major proportions, to say nothing of the problem of acquisition of land for disposal. There would certainly be duplication of expenditures that would make the cost of the service much higher than would be the case if one central disposal agency were created. It seems reasonable to assume that the private contractors would welcome the idea of having a central disposal agency, and some have voiced this opinion.

At the present time, as discussed in Section II, there are only three methods of disposal of solid wastes used in the United States, namely, the sanitary landfill method, the incineration method, and the composting method. The incineration method does not eliminate the need for land to dispose of the residue from the incineration of the refuse. The composting method, as discussed in Section II, does not eliminate the need for land since only certain materials in the refuse will compost, the balance must be disposed of by landfill, incineration and landfill, or salvage. To date, there has been no long time successful operation of composting of municipal refuse in the northern portion of the United States. In addition, compostible refuse in Genesee County accounts for less than 10% of the total; therefore, this method is not recommended. Thus, there remain basically only two methods that do warrant consideration - sanitary landfill and incineration followed by sanitary landfill.

Both methods have their individual advantages and disadvantages, as pointed out in Part II. However, before discussing either method of disposal for the County, it is necessary to examine carefully the materials that will be handled.

Table IV-5, on page IV-29, shows the projected refuse generation for the three types of refuse--domestic or residential, commercial, and industrial. The physical analysis of the domestic refuse indicates that either sanitary landfill or incineration would be a satisfactory method to use in its disposal. Combustibles made up almost 75 percent of the composite sample (see Table IV-1A, on page IV-9). The estimated analysis of the commercial refuse also indicates that either sanitary landfill or incineration would be a satisfactory method for the disposal of this refuse. The estimated analysis in Table IV-3, on page IV-16, indicates 85 percent of the commercial refuse is combustible.

Examination of Table IV-4, on page IV-18, shows that almost 40 percent of the industrial solid waste is combustible, not including the slurries and sludges, some of which do contain combustible material. Slurries and sludges make up approximately 20 percent of the industrial waste. The balance of the industrial solid wastes is made up of ashes (28%), glass (0.4%), pavement and concrete (6.2%), dirt and sand (0.6%), floor sweepings (0.8%), cans, bands and wires (3.6%), chemicals and explosives (.03%). With the exception of the chemicals and explosives all of the latter categories are non-combustible inert materials.

In addition to the above materials, referring again to Section IV, page IV-23, the other materials, such as dead and diseased trees, demolition material, and dead animals, make up the balance of the County's solid wastes. It is estimated that these items are combustible and non-combustible as follows:

Material	Combustible	Non-Combustible
Dead and Diseased Trees	100%	
Demolition Material	74%	26%
Dead Animals	100%	

The above three items and the industrial solid wastes could, and should, be delivered to a central disposal agency on a segregated basis. A combined refuse collection is the most economical for both domestic and commercial refuse. Both the City of Flint and the private collectors operate with combined collections; therefore, this portion of the County's total refuse would be delivered on a non-segregated basis. Table V-1, on the following page, lists the Engineers' opinion of acceptability of all the different solid wastes by a County-wide disposal agency as well as method of disposal.

TABLE V-1

SOLID WASTES - RECOMMENDED ACCEPTANCE AND DISPOSAL

Classification of Solid Wastes	Acceptable	Disposal Methods Sanitary Landfill (SLF) Incineration (INC)
Domestic, Commercial & Institutional Mixed Refuse	Yes	SLF or INC
Industrial Garbage, Paper, Canvas, Rags, Wood*, Rubber, Plastics & Trimming	Yes	SLF or INC
Industrial Oils & Thinners	Yes	Liquid & Sludge Destructor
Industrial Slurries & Sludges containing Dead Paint, Buffing Lint, Flour, Grease & Oils	Yes	Liquid & Sludge Destructor
Industrial Slurries & Sludges containing Water Softening Sludges, Grinding & Abrasive, & Aluminum Oxide (Inert Solids)	Yes	SLF
Industrial Slurries & Sludges containing Cleaning Compounds	Yes(1)	SLF
Industrial Chemicals	Yes(1)	SLF
Industrial Ashes	Yes	SLF or Fill for low-marsh areas
Industrial Pavement & Concrete	Yes	SLF or Fill for low-marsh areas
Industrial Dirt & Sand	Yes	SLF
Industrial Floor Sweepings	Yes	SLF
Industrial Cans, Bands & Metal	Yes(2)	SLF
Industrial Glass	Yes(2)	SLF
Industrial Explosives	No	-
Trees-Dead & Diseased	Yes	SLF or Special Wood Burner
Demolition Lumber	Yes	SLF or Special Wood Burner
Demolition Concrete, Dirt, Etc.	Yes	SLF
Dead Animals	Yes	Pathological Incinerator

* Industrial wood would be acceptable for SLF or INC; however, large items could be processed in Special Wood Burner.

(1) Only if neutralized - no acid, caustic or water soluble materials acceptable.

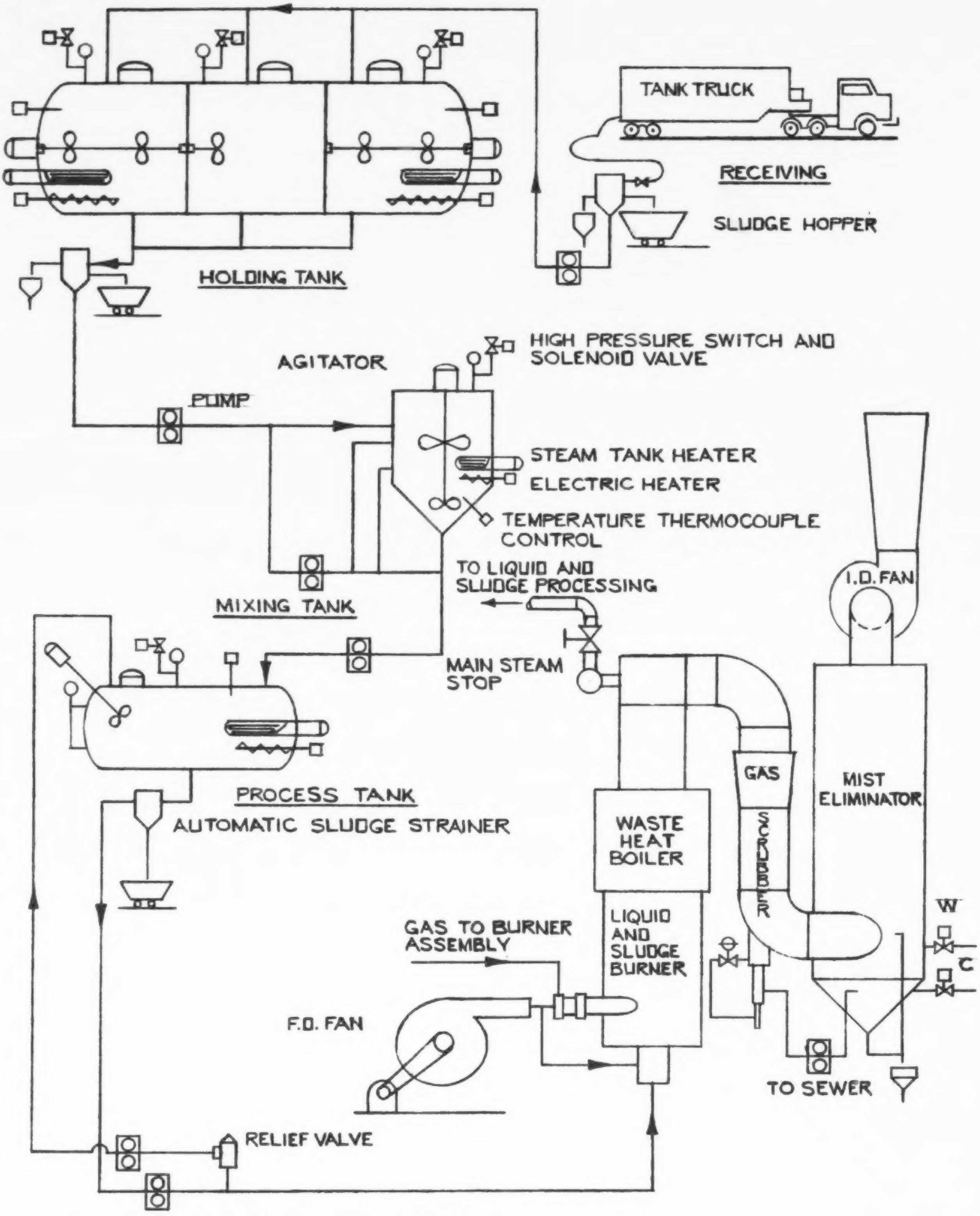
(2) Salvageable material should be removed before delivery to disposal authority.

It should be noted from examination of Table V-1 that with very few exceptions all of the solid waste generated within the County would be acceptable to a central disposal agency. Certain wastes require special treatment before being acceptable, others require special disposal methods. Even in those requiring special disposal methods, it is the Engineers' opinion that a central disposal agency could handle these more efficiently since they originate in a number of different plants.

2. Handling Special Wastes

It will be noted in Table V-1, on page V-14, that it is recommended that the industrial combustible oils and thinners be accepted. These materials along with certain of the industrial slurries and sludges are not suitable for sanitary landfill disposal direct, nor can these wastes be efficiently disposed of in a mixed refuse incinerator. Therefore, a special liquid and sludge destructor is recommended for disposal of these wastes. Air pollution control equipment should be included in the unit to eliminate the pollution problem. Figure V-2, on the following page, indicates the major components of such a unit.

FIGURE V-2


TANK TRUCK
RECEIVING
SLUDGE HOPPER
HOLDING TANK
AGITATOR
HIGH PRESSURE SWITCH AND SOLENOID VALVE
PUMP
STEAM TANK HEATER
ELECTRIC HEATER
TEMPERATURE THERMOCOUPLE CONTROL
MIXING TANK
TO LIQUID AND SLUDGE PROCESSING
I.D. FAN
MAIN STEAM STOP
GAS
MIST ELIMINATOR
PROCESS TANK
AUTOMATIC SLUDGE STRAINER
WASTE HEAT BOILER
SCRUBBER
LIQUID AND SLUDGE BURNER
W
C
GAS TO BURNER ASSEMBLY
F.D. FAN
TO SEWER
RELIEF VALVE

W — WATER MAKE-UP SOLENOID VALVE
C — CHEMICAL FEED AND SOLENOID VALVE FROM PUMP

LIQUID AND SLUDGE DESTRUCTOR

There are certain other solid wastes in addition to the industrial wastes discussed above that are recommended to be accepted by the central disposal agency, but which may require special treatment for disposal. One item is combustible wood, such as tree stumps, logs and branches and combustible material from demolition operations that must be disposed of. Since the advent of the Dutch Elm disease, the disposal of many trees has been the responsibility of public agencies, such as municipalities, park districts, townships, etc. At the present time, there are only two acceptable methods of disposal of this material, sanitary landfill or incineration. If there is sufficient land available, and the problem of settlement is not important, sanitary landfill will certainly be the least expensive method of disposal, with no further treatment of these wastes. Because of the bulk of these wastes they are difficult to handle. Many voids develop when all of this material is deposited in a landfill operation. Wood hoggers have been used to reduce the volume required at the landfill. Such a facility could provide wood chips as recommended in the City of Flint Recreation and Park Board Report on Solid Wood Waste. However, if the waste is diseased trees they should be either buried or burned. If all of the wood is hogged it could also be incinerated with mixed refuse. However, it is difficult and extremely expensive to hog logs, tree trunks and roots that are larger than about 12 inches in diameter, and, since these large logs, etc., burn so slowly, they cannot be introduced into the normal mixed refuse incinerator. Therefore, if burning of these wood wastes is justified to reduce the volume a special wood burning incinerator should be utilized. Air pollution control equipment must be included to prevent a smoke nuisance. The ash from such a burner could be disposed of readily in the landfill.

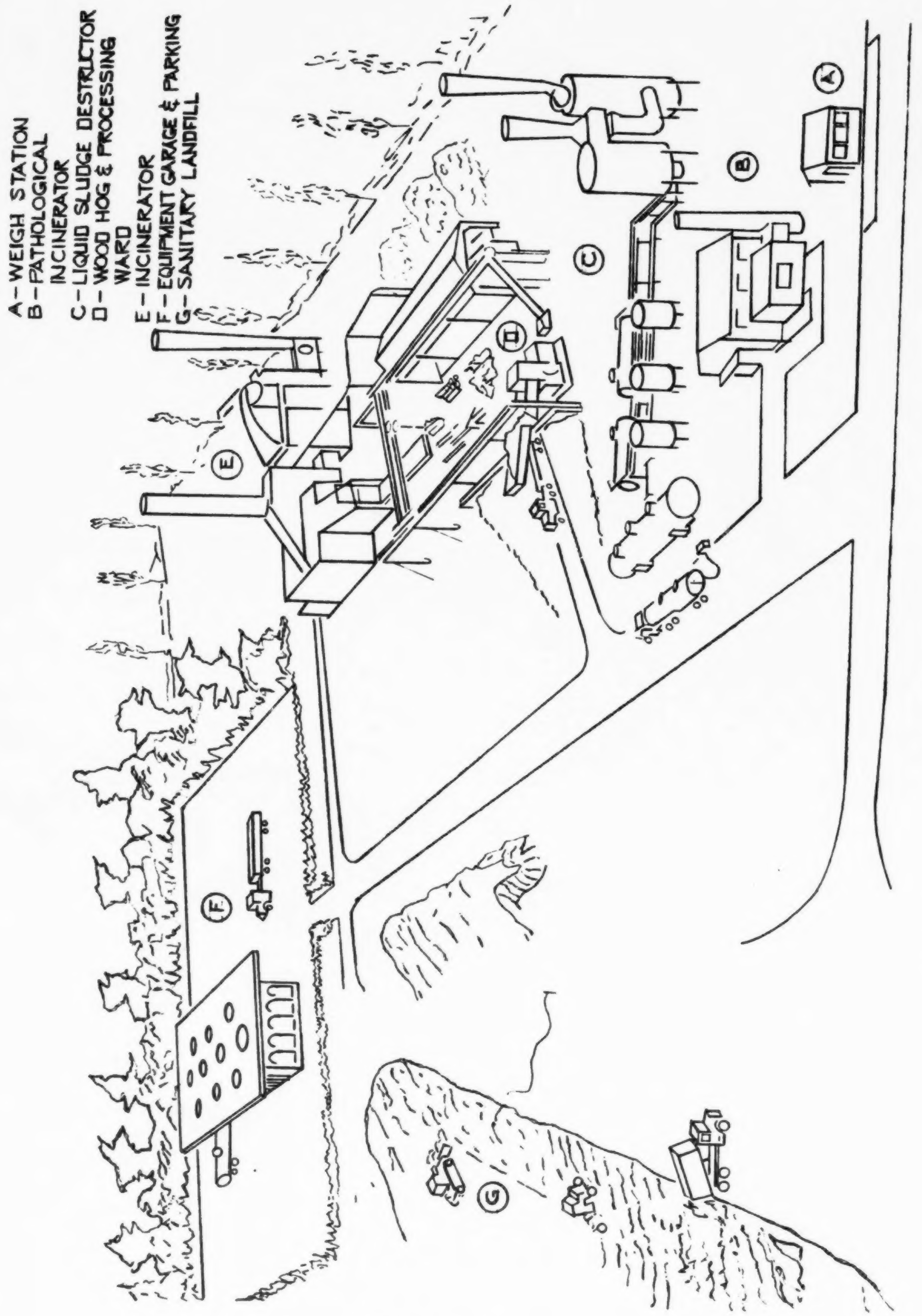
The operation of either a wood hogger or a wood burning facility would be intermittent unless storage is provided at the site since the generation is not uniform each day of the week. Tree trimming and removal is spasmodic and depends upon the season. In the City of Flint this work is done in the warmer five months of the year. Demolition operations normally extend only about nine months out of the year and are not uniform each day.

The City of Flint picks up approximately 3,000 dead animals at present. These are disposed of in the sanitary landfill operation. Disposal of such material into a sanitary landfill is not the best solution as it does not insure against the transmission of infection that may occur when the disposal method is sanitary landfill. To eliminate the problem all dead animals should be cremated.

Genesee County presently operates a small incinerator or crematory for disposal of dead dogs. This unit would not be adequate to dispose of all the dead animals that must be disposed of. An adequate animal or pathological incinerator should be built. The location could be at the same location as the present County animal incinerator. However, since this may result in both a space and traffic problem, it is recommended that the proposed unit be installed in conjunction with the liquid and sludge destructor and the special wood burner if included.

It is the Engineers' opinion that these three special waste facilities should be located at one location as near the major generation area as possible. Such location or site should also be adjacent to the site of other disposal facilities - either a sanitary landfill location or an incinerator location. Figure V-3, on the following page, indicates general arrangement for such facilities at a disposal site.

Table V-1 indicates that industrial ashes, pavement and concrete are acceptable and can be disposed of either in a sanitary landfill or in low-marsh areas. Such areas do exist in the southern half of the County. It is the Engineers' recommendation that this material be disposed of in the low-marsh areas to fill in such land. Since these wastes are relatively inert, using this material as fill could provide usable land at the completion of the filling operation with no appreciable amount of settlement such as would be the case with a sanitary landfill operation. Since the Michigan law includes ashes as refuse a license would be required for such an operation.


A – WEIGH STATION
B – PATHOLOGICAL INCINERATOR
C – LIQUID SLUDGE DESTRUCTOR
D – WOOD HOG & PROCESSING WARD
E – INCINERATOR
F – EQUIPMENT GARAGE & PARKING
G – SANITARY LANDFILL
A
B
C
D
E
F
G

GENERAL ARRANGEMENT OF DISPOSAL AREA

FIGURE V-3

Since the operation of such a site for the disposal of ashes, concrete, etc., may be on an intermittent basis, it may not require full-time personnel and equipment. Spare equipment and relief personnel from a nearby zone might be utilized to provide a more economical operation. Relief personnel must be included for the landfill operation, and thus all personnel could be gainfully employed.

3. Sanitary Landfill Method

A number of criteria have been set up for the ideal landfill site. It should be near the center of its collection area to minimize the average length of haul from the point of pick-up to the disposal site. It should be served by an adequate network of all-weather roads, so as to be easy of access at all times. It should be convenient to electric power lines, water supply and sanitary sewers. It should be in a sparsely populated region, with little or no building on or near it. Open prairie land is desirable, with little heavy brush and no dense woodlands. To avoid any danger of polluting ground water supplies, dry land is preferred, well above the local water-table, and it should also be free of standing or running surface water, such as lakes, rivers, streams, creeks and drainage ditches. It will readily be seen that a number of these qualities, while not necessarily incompatible, are not likely to be found in the same piece of real estate. Some compromise is inevitable, and the final selection should be based on the best available combination of features, in land that can be obtained at a reasonable figure.

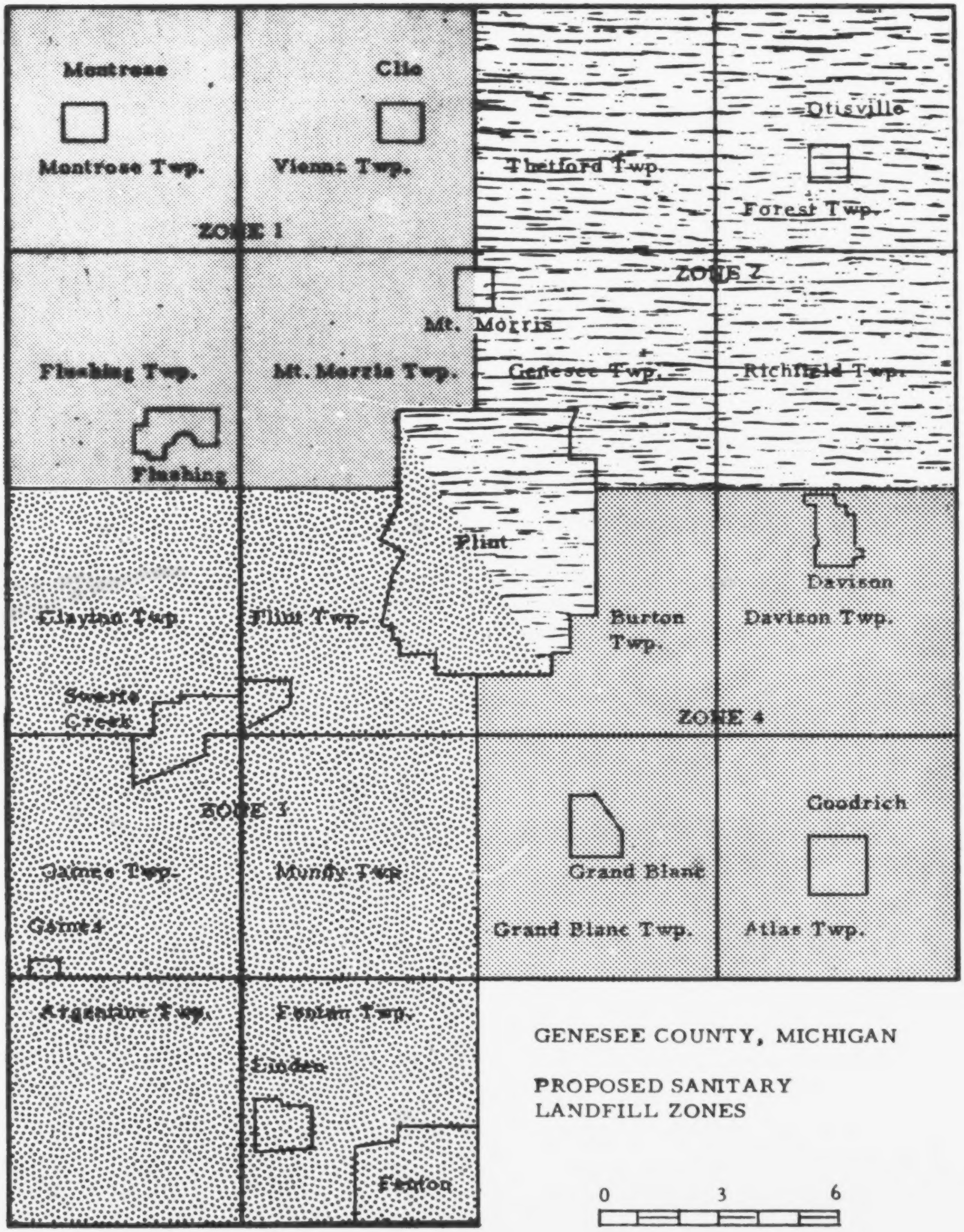
In order to determine if suitable land exists within the County the Engineers made a visual survey of the County, utilizing aerial maps that have been made of the entire County. After locating what appeared to be satisfactory unimproved land, visits were made to the various locations to verify their suitability for a sanitary landfill operation. From this survey it is their opinion that at this time there exists approximately 4,700 acres of unoccupied land within the County that would be suitable for use by the sanitary landfill method. It should be pointed out here that land suitable for sanitary landfill would also be suitable for deposition of incinerator residue--the regulations by the Michigan Department of Public Health are identical for both types of operation.

All of the sites are accessible either by concrete or bituminous surfaced roads, with one exception; that site is adjacent only to a soil-cement based road. Test borings would have to be made at each site to provide positive determination of ground water depths before final negotiations were entered into for acquisition. All but one of the sites are traversed by watercourses, varying from the Flint River and Kearsley Creek down to minor drainage ditches with only intermittent flow. If these sites are to be used, meticulous precautions will have to be taken to insure that no contamination reaches these streams. They are all located in areas of relatively sparse population, and with one exception have little building on or near the property. Electric service is accessible to each site, but in most cases water would have to be supplied from wells. Sewers are being extended into the outskirts of the metropolitan area, but it is doubtful that they will reach most of these sites for some time. None of the proposed sites is particularly swampy or heavily wooded.

If one large tract of land existed suitable for all the foreseeable future requirements of a sanitary landfill type disposal for the County, this might prove to be the most efficient type of operation. As previously pointed out, the ideal sanitary landfill site should be in the center of its collection area. Since the City of Flint occupies almost the center of Genesee County, it is not possible to locate one site in the center of the County. Also, no one tract exists within the County that could be utilized over the next 30 to 40 years. Therefore, a compromise was necessary and the Engineers divided the County into various disposal zones (see Figure V-4, on page V-24). In each of these zones there exists at least one of the surveyed sites suitable for sanitary landfill disposal of that zone's refuse. These can be utilized well into the next century. This statement, of course, assumes that the projections of generation of refuse and population are reasonably valid, and that only material suitable for sanitary landfill will be deposited therein.

As a central disposal agency, a sanitary landfill operation could be carried on in the four disposal zones very efficiently. Spare equipment to insure continuity of operation in case of breakdown would not need to be duplicated at each zone disposal site, but could be kept at a central location and taken where it was needed. Certain specialized equipment for particular operations could be handled the same

FIGURE V-4


Montrose
Clio
Montrose Twp.
Vienna Twp.
Otisville
Thetford Twp.
Forest Twp.
ZONE 1
ZONE 2
Mt. Morris
Flushing Twp.
Mt. Morris Twp.
Genesee Twp.
Richfield Twp.
Flushing
Flint
Davison
Clayton Twp.
Flint Twp.
Burton Twp.
Davison Twp.
Swartz Creek
ZONE 4
ZONE 3
Goodrich
Gaines Twp.
Mundy Twp.
Grand Blanc
Gaines
Grand Blanc Twp.
Atlas Twp.
Argentine Twp.
Fenton Twp.
Linden
Fenton
0
3
6

GENESEE COUNTY, MICHIGAN

PROPOSED SANITARY
LANDFILL ZONES

way, providing more efficient operation of each disposal site without the excessive cost of idle equipment. Since refuse collector trucks do not have to travel much further than they do at present to their respective disposal sites, transportation costs should remain low. Collection areas could be adjusted in the future as necessary to permit the most flexible handling of the refuse at each site.

The majority of sanitary landfill operations are obtaining only about a 45% compaction ratio using the bulldozer as the compactor. In other words, if material dumped into the landfill has a density of, say, 375 lbs. per cubic yard before the landfill compaction operation, at a 45% compaction ratio it would have a maximum density when compacted of about 550 lbs. per cubic yard. A few sanitary landfill operations are obtaining much higher compaction ratios, even as high as 100%. It is quite obvious that the higher compaction ratios will result in less acreage requirements. However, if a compaction ratio of 45% is applied in determining the acreage for a sanitary landfill operation, the result would be the very maximum land requirements, thus providing a factor of safety if better compaction is obtained.

If the material prior to placement in the landfill could be processed to increase its density, this would materially reduce the amount of land required. A method currently being investigated to accomplish this is the grinding of mixed refuse. Grinding of the mixed refuse accomplishes the same thing that hogging does for wood. In practice, similar equipment is utilized. In Table V-2, on page V-27, the

Engineers have estimated the acreage required for the sanitary landfill method in the four disposal zones based on the following conditions:

Condition 1 All residential, commercial and industrial mixed refuse, acceptable without qualification (see Table V-1, on page V-14), less the industrial ashes, pavement and concrete, would go directly to the sanitary landfill in the zone where generated. The dead and diseased trees, the demolition lumber, concrete, dirt, etc., the neutralized industrial slurries and sludges and chemicals would all go to a sanitary landfill Zone 3 with no processing. The residue from the liquid and sludge destructor and the pathological incinerator would also go to the landfill in Zone 3. The industrial ashes, pavement and concrete would go to fill in low-marsh areas.

Condition 2 All residential, commercial and industrial mixed refuse, acceptable without qualification (see Table V-1, on page V-14), less the industrial ashes, pavement and concrete, would be processed through a grinder, then go to the sanitary landfill in the zone where generated. The dead and diseased trees and demolition lumber would be hogged and then deposited in the sanitary landfill along with the demolition concrete, dirt, etc., with 60% to Zone 2 and 40% to Zone 3. The neutralized industrial slurries and sludges and chemicals would be deposited in the zone in which it is generated. The residue from the liquid and sludge destructor and the pathological incinerator would go to the landfill in Zone 3. The industrial ashes, pavement and concrete would go to fill in low-marsh areas.

TABLE V-2

ESTIMATED SANITARY LANDFILL ACREAGE

Condition	Disposal Zone	Estimated Acres Required/Year Present	1985	1995
1	1	5.3	11.4	14.7
1	2	17.5	27.3	32.7
1	3	27.6	46.8	57.6
1	4	6.2	13.6	17.6
Estimated Total Acres Required Per Year for Condition 1		56.6	99.1	122.6

Estimated Total Acres Required through 1995 for Condition 1 - 2520 Acres.

Condition	Disposal Zone	Present	1985	1995
2	1	3.9	8.4	11.0
2	2	16.3	26.3	31.8
2	3	14.4	26.5	33.2
2	4	4.6	10.0	13.1
Estimated Total Sanitary Landfill Acres Required Per Year for Condition 2		39.2	71.2	89.1

Estimated Total Acres Required through 1995 for Condition 2 - 1830 Acres.

		Present	1985	1995
Estimated Acres Per Year of Low-Marsh Land Required for Industrial Ashes, Pavement and Concrete		11.7	16.8	19.6

Estimated Total Acres Required through 1995 of Low-Marsh Land for Industrial Ashes, Pavement and Concrete - 440 Acres.

It is quite apparent from examination of Table V-2 that utilizing Condition 1 under sanitary landfill method of disposal uses up 53.5% of the estimated 4,700 acres available in the County by 1995. Therefore, if greater compaction can be obtained, it would certainly prove worthwhile. Otherwise, even though the cost of operation under Condition 2 may be much higher than the simpler method, it may be necessary to adopt the more costly type of operation to conserve land.

Calculations of estimated acreage were made based upon the estimated per capita generation of solid wastes shown in Table IV-5, on page IV-29, and the present and projected populations for the four zones shown in Figure V-4, on page V-24.

It should also be pointed out that the estimated acreage was calculated based upon the assumption that each sanitary landfill zone site could be excavated to a depth of 10 feet and filled to a height of 5 feet above existing grade. If excavations could be made to lower elevations or if the sites could be filled to higher elevations, the required acreage would, of course, be reduced. However, until the plan is adopted and actual borings have been made the Engineers feel the above assumptions are valid.

The estimated required acreage for disposal of the industrial ashes, pavement and concrete in the low-marsh areas was based upon the assumption that the land could be filled to a depth of about 8 feet, then finished with at least 2 feet of well-compacted earth. If more cover were required, this would not affect the amount of acreage required.

The present populations in Zones 1 and 4 are approximately one-third of Zones 3 and 2, respectively. The amount of industrial waste presently generated in Zones 1 and 4 is also much lower than in the other two zones. Comparing the acreage requirements at present in Table V-2, on page V-27, we find that Zone 1 requires only about one-fourth of Zone 3 requirements, and that Zone 4 requires slightly more than one-third of Zone 2 requirements.

Ideally, the disposal site should be as near the center of the collection area as practical, and this is the approach the Engineers have used in the four zone arrangement. However, since the present generation of refuse in Zones 1 and 2 is small when compared to the other two zones, it may prove more economical to combine Zone 1 with Zone 3 and Zone 2 with Zone 4. This would be practical only until about 1985, based on the projected populations and refuse generation. To continue operation of only the disposal sites in Zone 2 and Zone 3 beyond 1985 would exhaust the acreage that would be available in these two zones before 1995.

In order to determine the savings that may result in the early years of operation, if only two disposal sites are utilized as against four sites, the estimates that follow for sanitary landfill facilities, equipment and personnel requirements will be made for operation of both two and four disposal sites. It should be pointed out that collector trucks in Zones 1 and 4 will have to travel longer distances than those in Zones 2 and 3 to reach the sanitary landfill operation if only two disposal sites are used. However, at present a number of the private collectors operate at approximately the same distance from their own disposal site. Therefore, this should not create a problem.

(a) Sanitary Landfill Facilities and Equipment Requirements

At each sanitary landfill site a truck scale for weighing each load as it is brought in should be installed. This will provide a basis for the charges to be assessed against each collection agency, public or private. At the same time, these accurate records will serve in the future to make reliable forecasts of the requirements of the disposal agency. At the disposal site for the industrial ashes, concrete, etc., in the southern part of the County, it should not be necessary to provide a truck scale, since charges for disposal of this material can be made on an estimated cubic yard basis. However, it is recommended that periodically the trucks collecting this material be weighed at one of the sanitary landfill sites before deposition is made. Record keeping is so vitally important in forecasting future trends it cannot be over-emphasized.

A building should be constructed at each site to provide an office for the Scale Clerk and Foreman, a locker room and sanitary facilities for personnel employed at the site, as well as for drivers of the collection trucks bringing refuse to the site. In addition, the structure should be large enough to house the equipment used in the operation. Truck fueling facilities should be provided at each site. One site should include a central maintenance garage for all mobile equipment. This could be at Zone 3 or at the disposal zone site where the liquid and sludge destructor and the pathological incinerator would be located.

The following Tables V-3 and V-3A list the estimated equipment required at each of the sites for both a two-site operation and a four-site operation. It should be noted that at Zone 3 site, auxiliary or spare equipment is indicated in both Tables. This equipment can be shuttled to the other zone and/or zones and to the low-marsh area as required. These Tables list the equipment the Engineers estimate would be required for Condition 1 (see page V-26). Condition 2 would require changes in equipment as follows:

Equipment	Table V-3	Table V-3A
Bulldozers	omit 1 spare	omit 1 spare
Truck Tractors	add 4	add 6
Dump Trailers	add 6	add 10

TABLE V-3

ESTIMATED MOBILE EQUIPMENT REQUIREMENTS FOR TWO SANITARY LANDFILL SITES

Equipment	Number Required	
	Zone 2	Zone 3
Bulldozer	2	2
Compactor	1	1
Scraper	1	1
Dump Truck	-	1*
Pick-up Truck	1	1
Auxiliary or Spare Equipment		
Bulldozer		1
Compactor		1
Front-end Loader		1
Watertank Trailers		2
Truck Tractors		2
Low-bed Trailer		1
Superintendent's Station Wagon		1

* 10 yard dump truck also serves the auxiliary disposal units for special wastes.

TABLE V-3A

ESTIMATED MOBILE EQUIPMENT REQUIREMENTS FOR FOUR SANITARY LANDFILLE SITES

Equipment	Number Required			
	Zone 1	Zone 2	Zone 3	Zone 4
Bulldozer	1	2	2	1
Compactor	1	1	1	1
Scraper	1	1	1	*
Dump Truck	-	-	1**	
Pick-up Truck	1	1	1	1
Auxiliary or Spare Equipment				
Bulldozer			1	
Compactor			1	
Front-end Loader			1	
Watertank Trailers			2	
Truck Tractors			2	
Low-bed Trailer			1	
Superintendent's Station Wagon			1	

* Scraper assigned to Zone 1 can be shuttled to Zone 4 or vice-versa.

** 10 yard dump truck also serves the auxiliary disposal units for special wastes.

Many sanitary landfill operations utilize only the versatile bulldozer to spread and compact the refuse. In reality, the bulldozer is not an efficient compactor since the weight is spread over considerable surface in the crawler treads. Therefore, since compaction is so important in extending the life of any landfill operation, separate compaction equipment is recommended at each site. The one spare unit can be utilized for peak loadings between the larger Zones 2 and 3, and still act as a spare in case of a breakdown of one of the regularly assigned compactors. The compactor is, in effect, a bulldozer mounted on sheeps-foot rollers instead of a crawler track. As the material being compacted becomes denser and resists the penetration of the studs or sheeps-foot, the weight of the machine is carried on a smaller and smaller area, which increases the compaction correspondingly.

A self-loading, self-propelled scraper is recommended for each of the two large sites--Zones 2 and 3--and one unit recommended for either Zone 1 or Zone 4. Such equipment can be utilized to make the initial excavation, carry the excavated material to suitable stockpiling areas, and return such material for cover material at the end of each day's operation. Since Zones 1 and 4 have much smaller requirements than either Zone 2 or Zone 3, the scraper assigned to, say, Zone 1 can be readily moved to Zone 4 as required.

Watertank trailers are required both for sprinkling of the roadways and refuse to eliminate dust and to assist in extinguishing any fires that may start accidentally in the combustible refuse. The two units recommended can adequately take care of the requirements of either a two or four site operation, at least until 1985.

The truck-tractors can be used to move the watertank trailers from one location to another. One can also be utilized with the low-bed trailer to transport any disabled equipment to the maintenance garage or to shuttle equipment between the various landfill sites. Each unit should be equipped with two-way radio.

Since the disposal site for industrial ashes, pavement and concrete is separated from any of the sanitary landfill operations, and since its operation may not be continuous, 5-day per week, the spare bulldozer can be utilized at this site when not otherwise in use. It could also be transported by one of the truck-tractors and the low-bed trailer.

In addition, it is recommended that each site be provided with a pick-up truck. These trucks should all be equipped with two-way radio as should each site's office. These light pick-up trucks would be used to transport personnel and take care of emergency errands.

The estimated personnel necessary to operate the facilities and equipment at the various sanitary landfill sites are listed in Tables V-4 and V-4A, on pages V-36 and V-37. Here again, it is assumed that for either a two site or four site operation special wastes will be disposed of at the Zone 3 site. Relief operators and other relief personnel are included at this zone. Also, it is assumed that such relief personnel can be utilized for the operation of the site for disposal of the industrial ashes, pavement and concrete as required. The Engineers are of the opinion that the liquid and sludge destructor assumed located at Zone 3 will be operated on a 24-hour basis, 7 days per week. Personnel requirements are based upon Condition 1 (see page V-26). If Condition 2 is utilized, it is the Engineers' opinion that two additional operators would be required at each zone, under either a two site or four site operation, plus two additional mechanics at Zone 3--the assumed central facility--since this additional mechanical equipment will require more maintenance. Also under Condition 2, four additional truck drivers would be required for the two site operation and six additional truck drivers for the four site operation.

TABLE V-4

ESTIMATED PERSONNEL REQUIREMENTS FOR TWO SANITARY LANDFILL SITES

Personnel Classification	Number of Personnel	
	Zone 2	Zone 3
Foreman	1	1
Bulldozer Operator	2	2
Compactor Operator	1	1
Scraper Operator	1	1
Scale Clerk	1	1
Spotter	1	1
Additional Personnel		
Superintendent		1
Relief Bulldozer Operator		1
Relief Compactor Operator		1
Relief Scale Clerk		1
Tractor-Truck Operator		2
Mechanic		1
Assistant Mechanic		1
Liquid and Sludge Destructor Personnel		
Foreman		3
Lab Technician		1
Operator		3
Helper		3
Pathological Incinerator Personnel		
Operator-Butcher		1
Truck Driver		1

TABLE V-4A

ESTIMATED PERSONNEL REQUIREMENTS FOR FOUR SANITARY LANDFILL SITES

	Number of Personnel			
Personnel Classification	Zone 1	Zone 2	Zone 3	Zone 4
Foreman	1	1	1	1
Bulldozer Operator	1	2	2	1
Compactor Operator	1	1	1	1
Scraper Operator	1	1	1	-
Scale Clerk	1	1	1	1
Spotter	1	1	1	1
Additional Personnel				
Superintendent			1	
Relief Foreman			1	
Relief Bulldozer Operator			1	
Relief Compactor Operator			1	
Relief Scraper Operator			1	
Relief Scale Clerk			1	
Relief Spotter			1	
Tractor-Truck Operator			2	
Mechanic			1	
Assistant Mechanic			1	
Liquid and Sludge Destructor Personnel				
Foreman			3	
Lab Technician			1	
Operator			3	
Helper			3	
Pathological Incinerator Personnel				
Operator-Butcher			1	
Truck Driver			1	

4. Incineration Method

As indicated in Table V-1, on page V-14, all of the domestic, commercial and institutional mixed refuse and the industrial garbage, paper, canvas, rags, wood, rubber, plastic and trimmings are acceptable for normal incineration. These solid wastes are estimated to presently approximate 810 tons per day, Monday through Friday. By 1985, the daily tonnages on a 5-day week basis (Monday through Friday) would approximate 1,065 tons, and by 1995, 1,210 tons per day on the same basis. The non-combustibles, cans, bottles, etc., in normal mixed refuse would merely pass through the incinerator with the combustible materials at temperatures far above that required for sterilization. The resulting residue would be inert material, having only about one-fifth the volume of the input material. This residue, of course, must be disposed of, and the new Michigan law on solid waste disposal treats incinerator residue the same as any other waste material. Therefore, there would be required a sanitary landfill operation even with the incineration method of disposal.

The non-combustible industrial wastes, such as glass, dirt, sand, floor sweepings, cans, bands, wires, etc., listed in Table IV-4, on page IV-18, could go directly to the sanitary landfill. The other items, such as oils, thinners and the slurries and sludges containing combustibles, would still require the use of the liquid and sludge destructor as discussed under the Sanitary Landfill Method of this Section.

Assuming the use of incineration to reduce the volume of mixed refuse from homes, commercial establishments and the industrial combustible refuse, then it follows that incineration of dead and diseased trees and demolition lumber should also be utilized to further reduce the volume of land required for sanitary landfill. As pointed out previously, the hogged wood could be burned in a refuse incinerator. It is very inefficient, however, to burn the large logs and tree trunks in a refuse incinerator since these items burn so slowly. Therefore, under the incineration method the Engineers would recommend that a special wood burner be included to burn these large logs and tree trunks and that the balance of the tree waste material and the demolition lumber be hogged and burned in the incinerator along with the mixed refuse.

The addition of the hogged trees and demolition lumber to the refuse incineration would result in the following estimated capacities for incineration:

	Tons/Day (Mon. thru. Fri.)
Present	1,030
1985	1,340
1995	1,520

In addition to the above capacities for incineration, there would be required a special wood burner for the large logs and tree trunks. It is estimated that the capacity of this facility should be:

	Tons/Day (Mon. thru. Fri.)
Present	29
1985	65
1995	92

Based upon the above concept of incineration of all combustible material, the total estimated acreage required for disposal of all incinerator residue and the acceptable non-combustible industrial wastes, but not including the industrial ashes, pavement and concrete, is as follows for the entire County's solid waste disposal:

Present	8. Acres/Yr.
1985	12. Acres/Yr.
1995	15. Acres/Yr.

Total Estimated Acreage Required through
1995 - 320 Acres

The above-estimated total acreage is approximately one-eighth of the acreage required for sanitary landfill of all solid waste and about one-sixth of the acreage required for sanitary landfill with ground refuse (see Table V-2, on page V-27). There is sufficient suitable land in any of the disposal zones discussed under the Sanitary Landfill Method to accommodate the incinerator residue and the non-incinerated refuse. The acreage required for disposal of the industrial ashes, pavement and concrete would remain the same.

To provide capacity for present requirements and to meet the anticipated increases to the year 1995 it is the Engineers' opinion that two incinerator plants should be considered. One plant should have three 300 ton per day capacity units, and the other should have two 300 ton per day capacity units. This would provide a total capacity of 1,500 tons per day, sufficient to have one unit as a spare or stand-by until about 1977, at which time a third unit could be added to the smaller plant. It is estimated that such a program would provide sufficient capacity with at least one stand-by unit through 1995.

Since the anticipated population growth indicates a large growth to the west and southwest of the City of Flint, the larger plant should be located in this area as close to the city limits of Flint as possible. The other plant could be located to the east or northeast of Flint. With these locations it would not be difficult to shift disposal from one to the other for normal maintenance of the incinerator units. Location of the two plants in these areas will result in collector trucks traveling at most about 12 miles one way from the outlying townships and communities to deliver their refuse to one of the incinerator plants. The density of population reduces materially as the extremities of the County are approached, traveling in almost any direction from Flint. Therefore, the frequency that collector trucks would travel from these areas to a central incinerator plant will be small as compared to the trips collector trucks in Flint and its immediate area will make to these plants.

Utilizing the incineration method, it is the Engineers' opinion that the pathological incinerator and the liquid and sludge destructor discussed under the Sanitary Landfill Method of this Section should be located adjacent to the larger incinerator plant as well as the central maintenance and storage garage. A wood hogger should be included at each plant; however, initially, the special wood burner should be included at only the larger plant site. In the future as more tree and demolition lumber wastes are generated a second wood burner could be built adjacent to the other incinerator plant.

(a) Incinerator Facilities and Equipment Requirements

To construct an incinerator plant of 900 ton per day capacity ten acres or more of land should be acquired. Plants of this capacity have been built on as little as three acres; however, such plants usually create traffic problems of ingress and egress when insufficient land is available, to say nothing of the ability to provide attractive screening areas around the plant. Since a sanitary landfill operation is required for the disposal of the incinerator residue, to say nothing of the other solid wastes that do not go to the incinerator, additional land should be included adjacent to each plant for the most economical operation.

As previously discussed, it is estimated that the acreage required, if the incineration method is utilized, amounts to approximately 320 acres through 1995. If 240 acres could be acquired at each plant site, there should be sufficient land for the entire operation. However, to acquire this much acreage at two sites close to the city limits of Flint may not be possible. Therefore, in the estimates of mobile equipment and personnel required for incinerator plants and sanitary landfill operations the Engineer has assumed that the incinerator plants are separated from the sanitary landfill sites by at least 4 miles. This results in utilizing the disposal sites in Zone 2 and Zone 3, as discussed under Sanitary Landfill Method.

Each incinerator plant should have at least one scale for weighing the trucks as they enter the plant. Whether a scale house is utilized or a scale office depends to some extent upon the site selected. The structure should include a large refuse pit capable of holding at least one peak day's refuse, complete with not less than two traveling cranes to transport the refuse from the pit to the incinerators charging hoppers. Three hundred (300) ton per day incinerator furnaces are recommended, each complete with air pollution control equipment. To provide ease of maintenance individual stacks, one for each furnace, are recommended. Since stack heights are sometimes limited by the site selected, it is difficult to determine the more detailed design features in a preliminary study.

Rugged ash handling equipment is required to convey the residue from the incinerator stoker discharge to the ash loading facilities. Since the residue must be transported to the sanitary landfill site ash trailers and truck-tractors are required.

Table V-5, following, lists the mobile equipment necessary at each plant and its sanitary landfill site. It is the Engineers' opinion that the spare equipment can also be utilized intermittently as required at the disposal site for the industrial ashes, pavement and concrete as discussed under the Sanitary Landfill Method in this Section.

TABLE V-5

ESTIMATED MOBILE EQUIPMENT REQUIRED FOR INCINERATION AND SANITARY LANDFILL OPERATION

Equipment	900 Ton/Day Plant Site	600 Ton/Day Plant Site
Truck-Tractor	1	1
Ash Trailers, 30 Cu. Yd. Capacity	2	2
Bulldozer	1	1
Self-Loading Scraper	1	*
Pick-up Truck	1	1
Dump Truck	1	*
Watertank Trailer	1	*
Superintendent's Station Wagon	1	
Low-boy Trailer	1	*
Spare Equipment		
Bulldozer	1	*
Truck-Tractor	1	*
Ash Trailer	1	*

*Equipment can be shuttled between plants and landfill sites as required.

The spare equipment can be utilized to take care of the disposal site for the industrial ashes, pavement and concrete that will probably be an intermittent operation. Such equipment can be readily transported between the two sanitary landfill sites and the ash disposal site with the tractor and low-boy trailer.

To staff such an operation Table V-6, following, lists the estimated number of personnel at each incinerator plant and the sanitary landfill sites. Personnel required for the operation of the pathological incinerator and the liquid and sludge destructor are not included as these remain identical to those shown in Table V-4, on page V-34. Relief personnel should be able to operate the equipment at the industrial ash, pavement and concrete disposal site, in addition to required work at either of the two sanitary landfill sites.

TABLE V-6

ESTIMATED PERSONNEL REQUIREMENTS FOR INCINERATION AND LANDFILL OPERATION

Classification	Incinerator Plants 900 Ton/Day	 600 Ton/Day
Incinerator Personnel		
Superintendent	1	
Assistant Superintendent		1
Incinerator Operator	7*	3
Assistant Incinerator Operator	7*	3
Ash Floor Attendant	4*	3
Dumping Floor Attendant	2	2
Crane Operator	7*	6
Wood Hog Operator	2	2
Maintenance Man	4*	3
Clerk	1	1
Scale Attendant	1	1
Truck Driver	4*	3
Laborer	1	1
Janitor	1	1
Sanitary Landfill Personnel		
Foreman	1	1
Bulldozer Operator	1	1
Self-Loading Scraper Operator	1	-
Truck Driver	1	-
Spotter	1	1
Scale Clerk	1	1
Watchman-Laborer	3	3
Relief Personnel		
Bulldozer Operator	1	
Self-Loading Scraper Operator	1	
Truck Driver	1	
Scale Clerk-Spotter	1	
Laborer	1	

*Relief personnel included can be shifted to the second incinerator plant as required. This personnel can also be utilized to operate the special wood burner.

NOTE: Personnel for Liquid & Sludge Destructor and Pathological Incinerator same as shown in Tables V-4 and V-4A.

VI. COSTS OF DISPOSAL

A. SPECIAL WASTES

As discussed in Section V, in addition to the three major methods of disposal considered by the Engineers, there were certain solid wastes that required special treatment or processing for disposal. These were as follows:

> Dead animals that were recommended to be disposed of by means of a pathological incinerator.
>
> Certain industrial slurries and sludges containing combustible materials that would not be acceptable and the industrial oils and thinners that are flammable. These wastes were recommended to be processed through a liquid and sludge destructor.
>
> Industrial ashes, pavement and concrete that are basically inert were recommended to be disposed of in low-marsh areas that exist in the southern part of the County.

The disposal of all the County's solid wastes is based on the concept of operation by a County-wide disposal agency.

All of the above special wastes disposal costs could be lumped together with the costs of the three basic methods of disposal. However, it is the Engineers' opinion that these waste items requiring different disposal methods or processes should be considered separately. The following Tables VI-1, VI-2 and VI-3 list the estimated capital costs, amortization costs, operation and maintenance expenses, utilities, etc., for these three wastes considered as requiring different treatment. The total estimated annual expense is then divided by the total present estimated annual tonnage of that particular waste to provide an estimate of cost of disposal on a per ton basis.

It should be pointed out that the Engineers assumed a price of $300 per acre for the low-marsh area required for the disposal of the industrial ashes, pavement and concrete. A higher land cost would effect the cost per ton of disposal since the estimated land costs represent approximately 13 percent of the estimated annual expense of disposal of these wastes.

In addition, it is assumed that delivery of the special waste to the disposal sites will be by agencies other than the central agency with the exception of the dead animals. The estimate in Table V-1, for the disposal of dead animals, assumes that collection of this portion of the County's solid waste would be performed by the central agency in the areas outside the City of Flint where the Department of Public Works performs this service.

TABLE VI-1

ESTIMATED COST OF DISPOSAL DEAD ANIMALS

Capital Cost Estimate	
Incinerator and Structure	
Pathological Incinerator Complete	$ 10,000
Building and Foundation	10,000
Utilities--Water, Sewers, Gas and Electric	8,000
Total Incinerator and Structure	$28,000
Mobile Equipment - 1 Truck	$ 6,000
Annual Expense Estimate	
Amortization Incinerator and Structure $28,000 @ 4-1/2% - 20 years	$ 2,200
Amortization Mobile Equipment $6,000 @ 4-1/2% - 5 years	1,400
Labor - 1 Operator, 1 Truck Driver	20,500
Water, Gas and Electric	4,300
Maintenance - Incinerator and Structure	2,300
Truck Operation and Maintenance	7,000
Miscellaneous Supplies	600
Administrative Expense	3,000
Total Estimated Annual Expense	$41,300
Estimated Present Annual Generation	140 Tons
Estimated Disposal Cost - $41,300 + 140 Tons	$295 per Ton

TABLE VI-2

ESTIMATED COST OF DISPOSAL
INDUSTRIAL OILS, THINNERS AND CERTAIN SLURRIES AND SLUDGES

Capital Cost Estimate

Liquid and Sludge Destructor	
Process Piping and Equipment	$325,000
Foundations and Structures	110,000
Utilities--Water, Sewers, Gas and Electric	46,000
Total Liquid and Sludge Destructor	$481,000

Annual Expense Estimate

Amortization Liquid and Sludge Destructor $481,000 @ 4-1/2% - 20 years	$ 37,000
Labor	98,000
Maintenance	24,000
Water, Gas and Electric	58,000
Miscellaneous Supplies, Etc.	1,500
Administrative Expense	18,100
Total Estimated Annual Expense	$237,600

Estimated Present Annual Generation	41,800 Tons
Estimated Disposal Cost - $237,600 ÷ 41,800	$5.70 per Ton

TABLE VI-3

ESTIMATED COST OF DISPOSAL
INDUSTRIAL ASHES, PAVEMENT AND CONCRETE

Capital Cost Estimate

Land - 450 Acres @ $300/Acre	$135,000

Annual Expense Estimate

Amortization Expense	
Land - $135,000 @ 4-1/2% - 20 years	$ 10,400
Mobile Equipment (applicable portion)	6,600
Security Fencing	1,200
Temporary Gate House and Sanitary Facility	1,600
Salary and Labor Costs	12,000
Mobile Equipment Operation and Maintenance	8,000
Cover Material	33,900
Electricity and Miscellaneous Expense	200
Administrative Expense	6,100
Total Estimated Annual Expense	$ 80,000
Estimated Present Annual Generation	84,300 Tons
Estimated Disposal Cost - $80,000 ÷ 84,300 Tons	$0.95 per Ton

B. SANITARY LANDFILL METHOD DISPOSAL COSTS

In Section V, two basic methods of disposal were considered under the Sanitary Landfill Method. The first method consisted of placing all material in the landfill without any processing prior to placement, except the special wastes. This method was further broken down into two operations. One with an operation of only two sites and one with four sites. Table VI-4, on pages VI-9 through VI-11, and Table VI-4A, on pages VI-12 through VI-14, show the estimated capital costs, the estimated annual expenses and the estimated cost per ton for the first method of operation with two sanitary landfill sites and with four operating sites.

It was estimated that this first method would require some 2,520 acres of land during the next twenty-eight years, or through 1995. In Table VI-4 (for a two site operation), the Engineers have assumed that only the total acreage suitable for sanitary landfill in both Zone 2 and Zone 3 would be purchased at present; this approximates 2,800 acres, and should be sufficient to the year 1995. However, as pointed out in Section V, it is recommended that by 1985 the operation be shifted to four disposal sites. In Table VI-4A (for a four site operation), the Engineers have based the estimated costs on the acquisition of 3,000 acres of land at the outset of the plan to provide sufficient land beyond the year 1995. In both tables an estimated cost per acre of $1,000 has been used. The amortization expense per year for the land purchase amounts to about 22.5 percent of the estimated total annual cost for the two site operation and about 18 percent for the four site operation. Therefore, if the cost of land varies materially either above or below the estimated $1,000 per acre, the cost per ton of disposal will be affected.

The second method of disposal proposed to grind all domestic, commercial and industrial mixed refuse, then deposit the ground refuse in a sanitary landfill. The tree wastes and demolition lumber would be hogged with disposal to the landfill the same as for the ground mixed refuse. All other wastes acceptable to a central disposal agency, except the special wastes, would go directly to landfill with no processing.

As in the first method of sanitary landfill disposal, estimates have also been made for the second method of disposal based on an operation utilizing only two disposal sites and one using four disposal sites. Tables VI-5 and VI-5A, on pages VI-15 through VI-20, show the estimated capital costs, the estimated annual expenses and the estimated cost per ton of these two types of operations for the second method of disposal with sanitary landfill.

This second method of sanitary landfill disposal was estimated to require some 1,830 acres of land between now and 1995. In the estimate the Engineers have rounded this to 2,000 acres and have assumed the purchase to take place at the inception of this method for both types of operation. The estimated cost of $1,000 per acre results in an annual expense for amortization of almost 13 percent of the total annual expense for the two site operation and about 9 percent for the four site operation.

As noted in Section V, compactor equipment is recommended for both methods of sanitary landfill. Using such equipment, the percentage of compaction should be materially increased over the 45 percent compaction percentage used in calculation of the required acreage. This equipment has not been used extensively in sanitary landfill operations in the past. Therefore, to provide a comparable cost per ton of refuse handled, to operations the reader may be familiar with, the Engineers have included at the end of each of the following Tables VI-4, VI-4A, VI-5 and VI-5A the estimated cost per ton if this equipment and operating personnel are omitted. It is the Engineers' opinion, however, that the better compaction obtained with this equipment will, in the long run, be of great benefit in lengthening the life of each sanitary landfill site.

TABLE VI-4

ESTIMATED COST OF DISPOSAL SANITARY LANDFILL METHOD USING TWO DISPOSAL SITES

Capital Cost Estimates

Land - 2,800 Acres @ $1,000/Acre	$2,800,000	
Structures and Utilities		
1 - Disposal Site Building with Equipment Storage	84,000	
1 - Disposal Site Building and Maintenance Garage	150,000	
2 - Disposal Site Fueling Facilities	8,000	
2 - Disposal Site Water Supplies	20,000	
2 - Disposal Site Sanitary Waste Facilities	10,000	
Total Land, Structures and Utilities		$3,072,000
Land Improvements		
Roadways and Paving	$ 120,000	
Roadway and Area Lighting	40,000	
Fencing	12,000	
Total Land Improvements		$ 172,000
Building Furnishings and Equipment		
2 - Disposal Site Building Office Furnishings	$ 5,000	
2 - Disposal Site Building Office Equipment	3,000	
Maintenance Garage Equipment	16,000	
Total Building Furnishings and Equipment		$ 24,000
Sub-Total Carried Forward		$3,268,000

Table VI-4, Using Two Disposal Sites (Sheet 2)

Capital Cost Estimates (Continued)

Sub-Total Brought Forward		$3,268,000
Mobile Equipment		
5 - Bulldozers	$ 275,000	
3 - Compactors	173,000	
2 - Scraper-Loaders	80,000	
1 - Front-End Loader	20,000	
2 - Watertank Trailers	20,000	
1 - Low-Bed Trailer	12,000	
2 - Truck Tractors	44,000	
1 - Dump Truck	15,000	
2 - Half-Ton Pick-up Trucks	6,000	
1 - Station Wagon	3,000	
Radio Equipment	5,000	
Total Mobile Equipment		$ 653,000
Total Estimated Capital Cost for a Two Site Operation		$3,921,000

Table VI-4, Using Two Disposal Sites (Sheet 3)

Annual Expense Estimate

Amortization Expense	
Land, Structures and Utilities - $3,072,000 @ 4-1/2% - 20 years	$ 236,200
Land Improvements - $172,000 @ 4-1/2% - 10 years	21,700
Building Furnishings and Equipment - $24,000 @ 4-1/2% - 5 years	5,500
Mobile Equipment - $653,000 @ 4-1/2% - 5 years	148,700
Total Amortization Expense	$ 412,100
Operation and Maintenance Expense	
Salaries and Labor	$ 250,900
Mobile Equipment	173,000
Utilities, Supplies, Etc.	47,000
Building Maintenance	12,000
Total Operation and Maintenance Expense	$ 482,900
Administrative Expense	$ 69,000
Total Estimated Annual Expense	$ 964,000
Estimated Present Annual Generation	324,600 Tons
Estimated Disposal Cost if Operation is at Two Sites $964,000 ÷ 324,600 Tons	$ 2.97 per Ton

NOTE: If the 3 compactors and the operating personnel for this equipment were not included in the above estimate, the cost per ton of refuse handled would be approximately $2.60 per ton.

TABLE VI-4A

ESTIMATED COST OF DISPOSAL
SANITARY LANDFILL METHOD
USING FOUR DISPOSAL SITES

Capital Cost Estimates

Land - 3,000 Acres @ $1,000/Acre	$3,000,000	
Structures and Utilities		
3 - Disposal Site Buildings with Equipment Storage	252,000	
1 - Disposal Site Building and Maintenance Garage	150,000	
4 - Disposal Site Fueling Facilities	16,000	
4 - Disposal Site Water Supplies	40,000	
4 - Disposal Site Sanitary Waste Facilities	20,000	
Total Land, Structures and Utilities		$3,478,000
Land Improvements		
Roadways and Paving	$ 240,000	
Roadway and Area Lighting	80,000	
Fencing	24,000	
Total Land Improvements		$ 344,000
Building Furnishings and Equipment		
4 - Disposal Site Building Office Furnishings	$ 10,000	
4 - Disposal Site Building Office Equipment	6,000	
Maintenance Garage Equipment	16,000	
Total Building Furnishings and Equipment		$ 32,000
Sub-Total Carried Forward		$3,854,000

Table VI-4A, Using Four Disposal Sites (Sheet 2)

Capital Cost Estimates (Continued)

Sub-Total Brought Forward		$3,854,000
Mobile Equipment		
7 - Bulldozers	$ 385,000	
5 - Compactors	288,000	
3 - Scraper-Loader	120,000	
1 - Front-End Loader	20,000	
2 - Watertank Trailers	20,000	
1 - Low-Bed Trailer	12,000	
2 - Truck Tractors	44,000	
1 - Dump Truck	15,000	
4 - Half-Ton Pick-up Trucks	12,000	
1 - Station Wagon	3,000	
Radio Equipment	11,000	
Total Mobile Equipment		$ 930,000
Total Estimated Capital Cost for a Four Site Operation		$4,784,000

Table VI-4A, Using Four Disposal Sites (Sheet 3)

Annual Expense Estimate

Amortization Expense		
Land, Structures and Utilities - $3,478,000 @ 4-1/2% - 20 years	$	267,400
Land Improvements - $344,000 @ 4-1/2% - 10 years		43,500
Building Furnishings and Equipment - $32,000 @ 4-1/2% - 5 years		7,300
Mobile Equipment - $930,000 @ 4-1/2% - 5 years		211,800
Total Amortization Expense	$	530,000
Operation and Maintenance Expense		
Salaries and Labor	$	318,000
Mobile Equipment		262,000
Utilities, Supplies, Etc.		63,000
Building Maintenance		20,000
Total Operation and Maintenance Expense	$	663,000
Administrative Expense	$	97,800
Total Estimated Annual Expense for a Four Site Operation	$	1,290,800

Estimated Present Annual Generation	324,600 Tons
Estimated Disposal Cost if Operation is at Four Sites $1,290,800 ÷ 324,600 Tons	$3.98 per Ton

NOTE: If the 5 compactors and the operating personnel for this equipment were not included in the above estimate, the cost per ton of refuse handled would be approximately $3.35 per ton.

TABLE VI-5

ESTIMATED COST OF DISPOSAL
SANITARY LANDFILL METHOD WITH GRINDING
USING TWO DISPOSAL SITES

Capital Cost Estimates

Land - 2,000 Acres @ $1,000/Acre	$2,000,000	
Structures, Equipment and Utilities		
1 - Disposal Site Buildings with Equipment Storage	84,000	
1 - Disposal Site Building and Maintenance Garage	150,000	
2 - Refuse Grinders Complete with Conveyors	380,000	
2 - Wood Hoggers Complete with Conveyors	380,000	
2 - Disposal Site Fueling Facilities	8,000	
2 - Disposal Site Water Supplies	20,000	
2 - Disposal Site Sanitary Waste Facilities	10,000	
Total Land, Structures, Equipment and Utilities		$3,032,000
Land Improvements		
Roadways and Pavement	$ 120,000	
Roadway and Area Lighting	40,000	
Fencing	12,000	
Total Land Improvements		$ 172,000
Building Furnishings and Equipment		
2 - Disposal Site Building Office Furnishings	$ 5,000	
2 - Disposal Site Building Office Equipment	3,000	
Maintenance Garage Equipment	16,000	
Total Building Furnishings and Equipment		$ 24,000
Sub-Total Carried Forward		$3,228,000

Table VI-5, Using Two Disposal Sites (Sheet 2)

Capital Cost Estimates (Continued)

Sub-Total Brought Forward		$3,228,000
Mobile Equipment		
4 - Bulldozers	$ 220,000	
3 - Compactors	173,000	
2 - Scraper-Loaders	80,000	
1 - Front-End Loader	20,000	
2 - Watertank Trailers	20,000	
1 - Low-Bed Trailer	12,000	
6 - Truck Tractors	132,000	
6 - Dump Trailers	105,000	
1 - Dump Truck	15,000	
2 - Half-Ton Pick-up Trucks	6,000	
1 - Station Wagon	3,000	
Radio Equipment	5,000	
Total Mobile Equipment		$ 791,000
Total Estimated Capital Cost for a Two Site Operation		$4,019,000

Table VI-5, Using Two Disposal Sites (Sheet 3)

Annual Expense Estimate

Amortization Expense	
Land, Structures, Equipment and Utilities - $3,032,000 @ 4-1/2% - 20 years	$ 233,100
Land Improvements - $172,000 @ 4-1/2% - 10 years	21,700
Building Furnishings and Equipment - $24,000 @ 4-1/2% - 5 years	5,500
Mobile Equipment - $791,000 @ 4-1/2% - 5 years	180,200
Total Amortization Expense	$ 440,500
Operation and Maintenance Expense	
Salaries and Labor	$ 348,200
Mobile Equipment	221,300
Refuse Grinder Maintenance	29,000
Wood Hogger Maintenance	21,000
Utilities, Supplies, Etc.	70,000
Building Maintenance	12,000
Total Operation and Maintenance Expense	$ 701,500
Administrative Expense	$ 69,000
Total Estimated Annual Expense for a Two Site Operation.....	$ 1,211,000
Estimated Present Annual Generation	324,600 Tons
Estimated Disposal Cost if Operation is at Two Sites $1,211,000 ÷ 324,600 Tons	$ 3.73 per Ton

NOTE: If the 3 compactors and the operating personnel for this equipment were not included in the above estimate the cost per ton of refuse handled would be approximately $3.36 per ton.

TABLE VI-5A

ESTIMATED COST OF DISPOSAL
SANITARY LANDFILL METHOD WITH GRINDING USING FOUR DISPOSAL SITES

Capital Cost Estimates

Land - 2,000 Acres @ $1,000/Acre	$2,000,000	
Structures, Equipment and Utilities		
3 - Disposal Site Buildings with Equipment Storage	252,000	
1 - Disposal Site Building and Maintenance Garage	150,000	
4 - Refuse Grinders Complete with Conveyors	760,000	
2 - Wood Hoggers Complete with Conveyors	380,000	
4 - Disposal Site Fueling Facilities	16,000	
4 - Disposal Site Water Supplies	40,000	
4 - Disposal Site Sanitary Waste Facilities	20,000	
Total Land, Structures, Equipment and Utilities		$3,618,000
Land Improvements		
Roadways and Pavement	$ 240,000	
Roadway and Area Lighting	80,000	
Fencing	24,000	
Total Land Improvements		$ 344,000
Building Furnishings and Equipment		
4 - Disposal Site Building Office Furnishings	$ 10,000	
4 - Disposal Site Building Office Equipment	6,000	
Maintenance Garage Equipment	16,000	
Total Building Furnishings and Equipment		$ 32,000
Sub-Total Carried Forward		$3,994,000

Table VI-5A, Using Four Disposal Sites (Sheet 2)

Capital Cost Estimates (Continued)

Sub-Total Brought Forward		$3,994,000
Mobile Equipment		
6 - Bulldozers	$ 330,000	
5 - Compactors	288,000	
3 - Scraper-Loaders	120,000	
1 - Front-End Loader	20,000	
2 - Watertank Trailers	20,000	
1 - Low-Bed Trailer	12,000	
8 - Truck Tractors	176,000	
10 - Dump Trailers	175,000	
1 - Dump Truck	15,000	
4 - Half-Ton Pick-up Trucks	12,000	
1 - Station Wagon	3,000	
Radio Equipment	11,000	
Total Mobile Equipment		$1,182,000
Total Estimated Capital Cost for a Four Site Operation		$5,176,000

Table VI-5A, Using Four Disposal Sites (Sheet 3)

Annual Expense Estimate

Amortization Expense	
Land, Structures, Equipment and Utilities - $3,618,000 @ 4-1/2% - 20 years	$ 278,200
Land Improvements - $344,000 @ 4-1/2% - 10 years	43,500
Building Furnishings and Equipment - $32,000 @ 4-1/2% - 5 years	7,300
Mobile Equipment - $1,182,000 @ 4-1/2% - 5 years	269,300
Total Amortization Expense	$ 598,300
Operation and Maintenance Expense	
Salaries and Labor	$ 478,000
Mobile Equipment	346,000
Refuse Grinder Maintenance	41,000
Wood Hogger Maintenance	21,000
Utilities, Supplies, Etc.	100,000
Building Maintenance	20,000
Total Operation and Maintenance Expense	$ 1,006,000
Administrative Expense	$ 97,800
Total Estimated Annual Expense for a Four Site Operation	$ 1,702,100
Estimated Present Annual Generation	324,600 Tons
Estimated Disposal Cost if Operation is at Four Sites $1,702,100 ÷ 324,600 Tons	$ 5.24 per Ton

NOTE: If the 5 compactors and the operating personnel for this equipment were not included in the above estimate, the cost per ton of refuse handled would be approximately $4.61 per ton.

C. INCINERATOR METHOD DISPOSAL COSTS

In addition to the two methods of sanitary landfill, the Engineers considered incineration of all domestic and commercial mixed refuse, and the combustible industrial refuse. Included in the incinerated wastes was the hogged tree wastes and demolition lumber. The large tree trunks that are difficult to hog because of their diameter were proposed to be burned in a special wood burner under this method of disposal. All residue from the incinerators and the wood burner would be transported to the sanitary landfill site serving that incinerator. Non-combustible solid waste from industry that is acceptable to a central disposal agency would be delivered directly to the landfill sites.

With this method of disposal it was estimated that only some 320 acres of land would be required through 1995 for the disposal of the County's solid waste, not including the industrial ashes, pavement and concrete. The Engineers in the following estimates of cost in Table VI-6 have used 500 acres at $1,000 per acre. The annual amortization cost for the purchase of this amount of land approximates 1-1/4 percent of the estimated annual expense for this method of disposal. It is readily seen that with this method of disposal the actual price of the land required for disposal has little effect upon the cost of disposal. Table VI-6 provides estimates of costs for this method of disposal.

TABLE VI-6

ESTIMATED COST OF DISPOSAL INCINERATION METHOD

Capital Cost Estimates

Land - 500 Acres @ $1,000/Acre	$ 500,000	
Structures and Equipment		
1 - 900 Ton/Day Incinerator Plant and Central Garage	8,000,000	
1 - 600 Ton/Day Incinerator	5,400,000	
2 - Wood Hoggers Complete with Conveyors	360,000	
1 - Special Wood Burner	285,000	
2 - Landfill Site Buildings	150,000	
2 - Landfill Site Utilities--Water, Sewerage and Fueling	38,000	
Total Land, Structures and Equipment		$ 14,733,000
Land Improvements - Landfill Sites		
Roadways and Pavement	$ 150,000	
Roadway and Area Lighting	50,000	
Fencing	14,000	
Total Landfill Improvements		$ 214,000
Building Furnishings and Equipment		
2 - Incinerator Offices Furnishings	$ 4,000	
2 - Incinerator Offices Equipment	4,000	
2 - Landfill Site Offices Furnishings	3,000	
2 - Landfill Site Offices Equipment	3,000	
Central Garage Equipment	8,000	
Total Building Furnishings and Equipment		$ 22,000
Sub-Total Carried Forward		$ 14,969,000

Table VI-6 (Sheet 2)

Capital Cost Expenses (Continued)

Sub-Total Brought Forward		$14,969,000
Mobile Equipment		
5 - Ash Trailers	$1 100,000	
3 - Truck-Tractors	66,000	
3 - Bulldozers	165,000	
1 - Scraper-Loader	40,000	
1 - Watertank Trailer	10,000	
1 - Dump Truck	15,000	
1 - Low-bed Trailer	12,000	
2 - Half-ton Pick-up Trucks	6,000	
1 - Station Wagon	3,000	
Radio Equipment	10,000	
Total Mobile Equipment		$ 427,000
Total Estimated Capital Cost		$15,396,000

Table VI-6 (Sheet 3)

Annual Expense Estimate

Amortization Expense	
Land, Structures and Equipment - $14,733,000 @ 4-1/2% - 20 years	$ 1,132,700
Land Improvements - $214,000 @ 4-1/2% - 10 years	27,050
Building Furnishings and Equipment - $22,000 @ 4-1/2% - 5 years	5,050
Mobile Equipment - $427,000 @ 4-1/2% - 5 years	97,300
Total Amortization Expense	$ 1,262,100
Operation and Maintenance Expense	
Salaries and Labor	$ 880,000
Mobile Equipment	142,000
Hogging Equipment	20,500
Utilities, Supplies, Etc.	160,000
Plant and Structure Maintenance	512,000
Total Operation and Maintenance Expense	$ 1,714,500
Administrative Expense	$ 97,800
Total Estimated Annual Expense	$ 3,074,400
Estimated Present Annual Generation	324,600 Tons
Estimated Disposal Cost - $3,074,400 ÷ 324,600 Tons	$ 9.47 per Ton

APPENDIX

pages A-1 to A-XX

FLINT-GENESEE COUNTY
SOLID WASTE DISPOSAL STUDY AND INVESTIGATION

Commercial and Institutional Questionnaire

Date____________________

1. Name of person completing questionnaire________________________

2. Company or Institution________________________________
Street and No.________________________________
City______________Zip Code________Phone______________

3. Type Business: Department____ Wholesale____ Drug____ Meat____
Newsstand____ Grocery____ Cleaning____ Hardware____
Barber or Beauty Shop____ Restaurant____ Printing Shop____
Variety____ Mail Order____ Filling Station or Garage____ Stationery____
Bus-RR-Air Terminal____ Institution____
School____ (Type: Elem.___Jr. High___High___College___Pvt.___)

4. Do you have cooking and eating facilities?________________________

5. What type fuel do you use for heating?________________________

6. Hours and days open________________________________

7. No. of employees__________No. of students (schools)______________
No. of patients (institutions)__________

8. Do you salvage paper?______ Do you separate rubbish and garbage?______

9. How do you presently dispose of solid waste?
Haul own_____ Municipal pick-up_____ Private incinerator_____
Private hauler_____ If private hauler, give name and address
____
____

10. Where is your solid waste disposed?________________________

11. Where is solid waste picked up? Curb___ Building___ Alley___ Other____

12. How much solid waste do you generate per week?__________________

13. Remarks:____
____
____

Thank you for your cooperation. PLEASE RETURN COMPLETED QUESTIONNAIRE IN THE ENCLOSED POSTAGE PAID ENVELOPE.

Genesee County Metropolitan Planning Commission
930 Beach Street
Flint, Michigan 48502

FLINT RECREATION AND PARK BOARD
Room 301, City Hall
Flint, Michigan 48502

January 30, 1968

REPORT - SOLID WOOD WASTE OF THE CITY OF FLINT

Because of the immediate nature of this report, we will outline it rather than attempt to present a finished complete diagnosis of our problem.

Part 1 - The Problem

A. Municipal Operations:

1. The Forestry Department of the Flint Recreation and Park Board acquires considerable amounts of tree brush, limbs, trunks and chips as a result of its trimming and tree removal programs.

   a. Wood chips are accumulated in an estimated annual rate of 2,000,000 pounds. All live brush and much of the dead limbs resulting from our trimming and removal operations are reduced to wood chips. It is estimated that 5 loads of brush can be reduced to 1 load of wood chips; and therefore, Chart Number 1 indicates that the Department hauls about 400 truck loads of chips annually (The total of 1008 loads of brush in 1967 could have been reduced to 400 loads of brush and 125 loads of chips if our chipping units had been operative that year).

   These chips can be utilized in park work, tree planting operations and general mulching operations at this rate and therefore do not present a problem of disposal.

   b. Brush: Approximately 400 loads of brush are accumulated annually by the Forestry Department. We estimate that amounts to about 100,000 pounds of wood annually. This brush is dead, crooked or thorny so that its reduction to chips is difficult. It could be chipped but at a high labor cost and with considerable wear of the chipper units. Another method of dispcsal is preferred.

   c. Wood: Chart Number 1 indicates that the Department hauls about 1,200 loads of wood each year. This wood consists of trunks and larger limbs from its tree trimming and removal program. This wood is largely elm which must be burned, buried or treated to prevent the spread of Dutch Elm Disease. During the prime period of removal work (from May to October) this treatment must be immediate.

   These 1,200 loads of wood have been converted to pounds of wood by multiplying the total by 320 cubic feet of truck space to find the total annual volume. This volume is multiplied by a conversion factor of 70% to give a solid wood volume. The weight of green elm (54 pounds per cubic foot) is used to arrive at the total annual accumulation of wood which we estimate at 15 million pounds.

CHART NUMBER I - RECORD OF LOADS OF WOOD, BRUSH AND CHIPS HAULED BY THE FORESTRY DEPARTMENT, FLINT RECREATION & PARK BOARD

		Loads of Wood	Loads of Brush	Loads of Wood Chips
1965	January	87	37	19
	February	107	8	12
	March	20	9	32
	April	10	8	19
	May	25	10	16
	June	47	93	9½
	July	111	47	46
	August	107	36	37½
	September	48	34	32
	October	42	12	34½
	November	14	17	4½
	December	39	61	12
	1965 Totals	667	372	244
1966	January	89	17½	16½
	February	153	8	16
	March	140	16	39
	April	99	8	17
	May	94	38	22
	June	68	51	47
	July	117	73	55
	August	145	52	55
	September	45	14	35½
	October	107	44	41
	November	91	32	30
	December	98	56½	26½
	1966 Totals	1,246	410	400
1967	January	85	57	22
	February	61	8	8½
	March	85	51	3
	April	82	35	6
	May	91	39	28
	June	119	110	71
	July	117	150	30
	August	198	174	38
	September	100	119	18
	October	74	122	11
	November	67	57	15½
	December	65	56	24
	1967 Totals	1,144	1,008	275

2. Other Departments of the City of Flint, notably the Department of Public Works, also accumulates wood waste. We have no record of these totals but would estimate it at 10% of the total of the Forestry Department. In addition, the D. P. W. hauls the wood from condemned homes which must be considered. Generally, the green wood consists of limbs, trunks and entire stumps. The latter item presents a serious problem which we feel can only be solved through a land fill operation.

B. Wood Waste From the Private Sector

No records are available for the amounts of brush and wood which accumulates from tree work on private property. However, records of condemned elms which must be removed from private property are shown in Chart II.

Based on these records, we would estimate that the annual wood accumulation from this sector is equal to Forestry Department total.

C. Genesee County Wood Accumulation

We can only estimate that wood accumulation from out-city sources would be considerably less than that of the city. The absence of a Dutch Elm Disease Control Program, the use of wood for fuel and the presence of vacant land where excess wood can be left is the basis for this estimate.

D. Peak Loads

A total of all estimated disposable wood accumulated from Genesee County annually is in excess of 30 million pounds. However, in the City of Flint, prompt disposal of elm wood during the months of May through September is vital to the Dutch Elm Disease Control Program. These months also produce more wood than the rest of the year, as shown by Chart III.

This chart shows that the City of Flint accumulates about 47% of its total annual wood waste in the five months period of May through September and about 36% of its wood waste in the three months summer period. Thus, during the summer months, about 5,400,000 pounds of wood is accumulated, or about 83,077 pounds per working day.

Part II - Possible Methods of Wood Disposal

There are generally two methods of wood disposal acceptable in a Dutch Elm Disease Control Program and therefore acceptable to Flint -- burning or burying. The City of Flint is presently using the land fill method. The present site is acceptable because it is about 5.6 miles from the Forestry Shop. The cost per trip of using this site is estimated at $10.36 or over $12,000.00 per annum. Each additional mile which must be traveled to a new site would increase our costs by 58.7¢ per trip or over $700.00 per year. These costs are in addition to the actual operation of the land fill site.

Burning in an open dump is not now practicable because of recent legislation by the State of Michigan. A report of smokeless incineration of

CHART II - TREE REMOVALS - CITY OF FLINT

Year	PUBLIC SECTOR		PRIVATE SECTOR		Annual Totals
	Condemned Elms	Other Removals	Contract Removals	Condemned Elms	
1957	66	201		257	524
1958	105	272		261	638
1959	237	308		280	825
1960	174	249		247	670
1961	260	318		462	1,040
1962	431	292		1,051	1,774
1963	370	211		936	1,517
1964	589	204	453	1,507	2,753
1965	1,142	188	395	1,891	3,616
1966	1,666	167	281	2,367	4,481
1967	2,304	331	516	2,567	5,202

CHART III - COMPARISON OF RECORDS - CITY OF FLINT TO DETERMINE PEAK LOADS OF WOOD

Year	Segment of Year	PERCENTAGE OF ANNUAL TOTAL		
		Loads of Wood Hauled	Number of Diseased Elms Removed [1]	Total Diameter Inches of Tree Removed [2]
1965	May thru Sept.	50.0%	55.0%	62.5%
	June thru July	40.0%	46.5%	58.0%
1966	May thru Sept.	37.6%	34.4%	31.5%
	June thru July	29.0%	21.7%	18.2%
1967	May thru Sept.	53.5%	66.0%	50.2%
	June thru July	37.7%	53.0%	40.0%
Average of 3 yr. period	May thru Sept.	47.0%	51.8%	48.0%
	June thru July	35.6%	40.4%	38.7%

1. Only condemned elms on public property used. See Chart II.

2. Obtained by multiplying each elm removed by its reported diameter in inches.

Note: Last two columns are used to show the validity of our records in arriving at the total number of loads of wood hauled.

Part II - Possible Methods of Wood Disposal (Contd.)

wood by the City of Detroit in special wood-brush incinerators was presented in the May, 1965 issue of Public Works Magazine. The report mentions a construction cost of $250,000.00 and an annual operation expense of $29,500.00.

It is felt that an operation which would reduce wood to wood chips should also be considered for the following reasons:

1. A useable product results
2. A more portable installation is possible
3. Preliminary research indicates that construction and annual operating cost may be less than the incineration method.

Part III - Research of a Chipping Installation

The Forestry Department of the Flint Recreation and Park Board has been working since 1956 on a possible solution to the problem of wood waste disposal by reducing these wastes to wood chips which could be utilized rather than destroyed. The project has waxed and waned as each crisis and its stop-gap solution presented itself. Basically, the research has revolved around a plant which would reduce logs and brush (that brush not normally able to be reduced by the mobile chippers now in use) to wood chips. The problems involved in this projected operation are:

A. Feasibility of chipping logs
B. Feasibility of chipping brush cheaply
C. Construction costs
D. Annual maintenance costs
E. Utilization of chips

A. Feasibility of Chipping Logs: Presently large brush "hogs" are used in pulp mills to reduce log "bolts" to wood chips. These hogs are stationery and are fed from the top. All of the research into mechanical apparatus to chip logs has been done through the Mitts and Merrill Corporation of Saginaw, Michigan. Other manufacturers of log chippers who have been contacted are the Fitchburg Engineering Corporation of Fitchburg, Massachusetts, and Hammermills, Inc. of the Pettibone Companies.

The Mitts and Merrill Corporation builds a large log chipper in 9" width sections with a cylinder diameter of 30 inches producing a feed opening from 20"x18" to 20"x54". The larger size has a capacity of 13,500 pounds of wood per hour with a screen and 22,500 pounds per hour without a screen. The Pettibone "Bulldog" Shredder has a feed opening capable of taking "up to telephone pole size" at a rate of 30 - 60 tons per hour. We are attaching copies of the latest correspondence received from both companies.

In order to process logs larger than 15"x15" (the largest size we feel can practically be chipped), some method of splitting them must be devised. At present there are log splitters on the market capable of splitting 8-foot long logs. These splitters are basically a low bed with a hydraulic ram at one end and a large metal wedge at the other. It would seem possible to construct such a machine to handle the largest logs encountered, even to utilizing a star-shaped wedge which would separate the log into chipable sizes without the necessity for re-splitting.

Feasibility of Chipping Logs (Contd.)

The physical handling of the logs from the unloading area to the chipper presents a problem. This operation would seem to involve large amounts of manual labor - a most expensive item. But we believe that the new log-handling equipment such as the Prentice or Hiab articulated cranes could resolve this problem effectively.

B. Feasibility of Chipping Brush Cheaply: Brush that can be chipped at the field site is most economically processed there (even though manual labor is involved) because of the reduced hauling costs. Various ratios of brush to wood chips have been achieved but we have used a conservative ratio of 5 loads of brush to one load of chips.

Our experience has shown that crooked, thorny and dead limbs are difficult and expensive to chip in the field. Some method of chipping this type of brush is necessary at the location of the waste disposal plant. In addition large amounts of brush from the private sector must be chipped (without hand feeding into a chipping unit if possible). The possibility of a compressing and bailing machine to compress loose brush into cylindical units capable of being chipped in the log chipper should be considered.

It is also conceivable that this type of brush could be processed in a garbage and waste incinerator if this type of solid waste disposal unit was used.

C. Construction Costs: Research in initial costs of a wood chipping installation has been confined to the basic mechanical units that have been suggested.

1. Basic mechanical "Hog" or chipper
   - (a) Attached is the 1966 quotations of the Mitts and Merrill #15-CSH Hog - Total estimated cost was $26,976.00. It is anticipated that a practical operation would have to have at least two such units to cover peak loads and mechanical breakdowns.
   - (b) The letter from the Pettibone Company quotes costs. The largest unit has a basic cost of $278,000.00.
2. Additional Equipment
   - (a) Prentice articulated booms - largest size is approximately $7,000.00.
   - (b) Collector system if needed is estimated at $5,000.00.
3. Suggested Equipment - No cost estimates available
   - (a) Log splitter unit (to be designed & built)
   - (b) Brush Bailer (to be designed & built)
   - (c) Caterpillar tractor and/or other material handling equipment
   - (d) Power saws
4. Site Construction: There has been no research into the site costs of the suggested operation. The following points should be considered, however:

   - (a) Considerable storage area for the wood chip product
   - (b) Considerable log and brush storage area

(c) Conveyor system from log and brush processing area to chipper unit(s)
(d) Sound-reduction system installed (in shelter) at chipper site
(e) Power plant
(f) Arrangements for fee collection

D. Annual Maintenance Costs: Annual maintenance costs are in direct proportion to amount of labor necessary, depreciation schedule of equipment, power charges and mechanical upkeep. The Mitts and Merrill Corporation assures us that maintenance of the chipper blades and cylinder in their hog is minimal; however, our experience with the portable brush chipper units leads us to believe that these costs will be sufficient to be an important factor in annual maintenance costs.

Labor costs would seem to be the major item. Minimal personnel should include a supervisor, a chipper operator, a log-brush processing operator, laborer, and a fee collector. If the log-brush processing equipment suggested can be efficiently designed, less labor will be required.

E. Utilization of Chips: Considerable research has been made on the final utilization of the end product envisioned. A bibliography of the information sources is as follows:

1. "Wood Chips for the Land", U.S. Department of Agriculture, Soil Conservation Service Leaflet No. 323.

2. "Agricultural and Horticultural Use of Wood Residues in California", W. A. Dost, Forest Products Journal, October, 1965, pp. 450-2.

3. "The Use of Sawdust for Mulches and Soil Improvement", U.S. Department of Agriculture, Circular No. 891, 1961.

4. "Marketable Sawdust Composts, Their Preparation and Fertilizing Value", S. A. Wilde, reprinted from November 1958, Forest Products Journal (Vol. VIII, No. II). Pages 323-326.

5. "Conservation and Use of Wood Chips", Homer L. Jacobs, Combined Proceedings of 35th National Shade Tree Conference, August 16-20, 1959. Pages 17-36.

6. "Uses of Slabs, Edging and Trims", U.S. Forest Service Research Note, Forest Products Laboratory, Madison, Wisconsin, March, 1964.

7. "Using Low-Grade Hardwood - A Proposed Integrated Plant Design", Peter Koch, Extension Bulletin 460, Cooperative Extension Service, Department of Forest Products, Michigan State University, East Lansing, Michigan.

8. "Tests of a Portable Wood Chipper", Station Paper No. 30, Lake States Forest Experiment Station, St. Paul, Minnesota, U.S. Department of Agriculture.

The general accepted uses of wood chips are: as a mulch around plants, as a soil conditioner, or as a surface covering for paths or playground equipment areas.

The Forestry Department of the Flint Recreation and Park Board has disposed of its wood chips in this manner for several years. We have sold some 175 yards of wood chips annually at $1.50 per yard, indicating a limited market. An undetermined amount of chips have been given to residents and school board officials for use as mulches. The remainder has been used around the Recreation and Park Board recreational facilities.

These outlets are sufficient for our present production but hardly adequate if the present wood wastes are converted into chips. As an added consideration, a market for this end product could reduce the annual expense considerably.

Dr. Wilde's paper describes the reduction of sawdust to a "black, mull-like ligneaus material" suitable as a soil additive and planting medium. We have not attempted to repeat his experimental procedures on our wood chips but believe that the uniform chip that may be expected from a screened hog can be reduced to this soil-like substance. A present market exists for topsoil, but especially for nutrient-reinforced potting soils. Dr. Wilde cites the cost of the process at $1.00 per cubic yard which indicates that this method might be profitably utilized.

Wood processing concerns indicate that the presence of bark in the proposed product would prohibit the use of these chips in paper and pressed board manufacture. However, the reference in 6 above, "Uses of Slabs, Edgings, and Trims" Table 3, indicates that green wood with bark could be used for the production of saturating or roofing felt, structural board, container board, insulating board, container and box board, soda pulp and Kraft pulp. If a local supply were available, Scott Paper in Detroit or other wood processors in Northern Michigan may be interested.

Reference 1 above, "Wood Chips for the Land" on page 4 and 5 indicate that a dry, uniform chip is sought by dairymen for cattle bedding. According to this research, about 200 cubic feet of dry wood chips would provide enough chips for one animal-year. Thus, the total estimated annual accumulation of wood chips from the City Forestry operations could be used by 4,000 animals, a figure which is well within the total number of dairy animals in the Southeastern area. This reference written in 1959 mentions cost of $5.00 per ton for wood chips as comparing favorably with straw, etc.

Thus, if would seem that if a proper marketing system were set up to dispose of these chips at a price and if a dumping fee were charged to private users, the annual cost of the entire operation may be recovered.

Part IV - Location of a Proposed Unit

Serious consideration should be given to locating such an installation within the Forestry Department and at the present Forestry Department site at 1106 S. Averill for the following reasons:

1. Location at this site would reduce hauling costs considerably for the City as a whole and especially for the Forestry Department, which contributes the largest percentage of the wood waste.

2. The Forestry Department has the general experience needed in handling wood and wood waste.

Part IV - Location of a Proposed Unit (Contd.)

3. Land, zoned for industrial use, is available behind the Forestry Center.

4. Rail facilities, if needed, are available.

5. Proper control of access site for private users facilitate the Forestry Department's control on disposal of diseased elm wood and in other diseased wood disposal problems.

A major disadvantage may be the noise resulting from the chipper operation. This could be reduced by proper design of the chipper shelter. Dust, traffic, and possible littering of access roads are other considerations especially to the residential development to the East of the Forestry Center. However, paving and design of access roads as well as proper policing could reduce these problems.

The land area available is presently isolated on the South by the proposed M-78 and M-21 freeway. It is bounded on the West by the C&C R.R., on the North by the Water Service Center, and on the East by Cook Park and the Forestry Center. The proposed freeway as well as the Averill-Court Street - Lapeer Road grid would give easy access to it from the entire county.

Your Collection Day Is: ______________________________

WASTE COLLECTION SERVICES

TO THE FLINT CITY RESIDENT:

We hope that you will enjoy living in Flint, the Cultural City.

As a member of the community, you are entitled to the following services. Observance of these rules will assure you of a weekly collection of garbage, tin cans, and combustible wastes.

GARBAGE - Material collected - table wastes which have been drained and wrapped. Container - 10 gallon tapered metal garbage can with proper cover.

PAPER - Household scrap paper should be placed in paper bags and tied and put in the garbage container or in a small cardboard box and set out beside the garbage container. Collectors will take the boxes, under these conditions, unless the householder is present to retrieve the box at the time of collection. Strong plastic bags may be used for scrap paper.

Newspapers and magazines will be collected if placed at the curb in small bundles tied with heavy cord.

TIN CANS - Material collected - tin cans, glass, metal objects which are normally accumulated about a residence.

Container - 15 gallon tapered metal garbage can with proper cover.

ASHES - Coal ashes will be picked up at the curb, if placed in a metal bushel basket. Incinerator ashes will be picked up if placed in paper sacks and placed in the tin can or refuse container as has been the past practice.

BRUSH & YARD DEBRIS - Grass clippings and leaves will be collected, if placed in suitable containers. Clippings will be collected if placed in suitable cardboard boxes or plastic bags. Cardboard boxes or plastic bags will be collected and not returned to the property owner. Also, bushel baskets may be used for fresh material.

SHURBERY CLIPPINGS & BRANCHES - Small quantities of shrubbery clippings will be collected, if placed in suitable containers. If placed in cardboard boxes, the container as well as the contents will be collected.

Small branches and clippings will be collected, if the material is cut and bundled in lengths not exceeding four (4) feet.

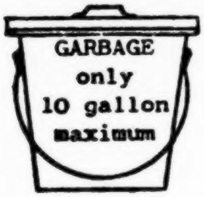
ALL ITEMS LISTED ABOVE, SHOULD BE PLACED AT THE CURB BY 7:00 A.M. ON THE DAY OF YOUR AREA'S SCHEDULED COLLECTION.

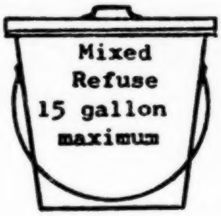
DEAD ANIMALS - These will be picked up in the City of Flint during the regular work week by calling CEdar 2-2831. On Holidays, Saturdays, and Sundays, call the Police Department, CEdar 2-4121.

Bulky items such as large pieces of furniture, stoves, and household equipment, will be picked up by the City during a spring clean-up week, which is usually the first week in May. The date is announced several weeks in advance and receives publicity through the newspaper, radio, and television.

Commercial wastes such as dirt, sand, gravel, and concrete are not collected by the Department.

Goodwill Industries and the Salvation Army have been picking up usable clothing, furniture and household equipment.





Maximum size of container permitted for mixed refuse, which would include quantities of garbage, paper, sacks of incinerator ashes, tin cans, and glass, is a 15 gallon tapered metal garbage can with a tight fitting cover.

Maximum size of container if used for garbage only, is a 10 gallon tapered metal garbage can with a tight fitting cover.

Metal bushel baskets should be used for ashes from home heating plants, brush and/or yard debris. Wooden bushel baskets may be used for brush and yard debris, shubbery clippings, and small branches. Plastic bags may be used for paper and grass clippings.

Plastic bags will be collected with the materials and not returned. Cardboard boxes may be used for brush and yard debris, shubbery clippings, and small branches and paper. Cardboard boxes will not be returned.

Plastic containers may not be used in place of the 15 and 10 gallon cans.

You are entitled to the listed services, as approved by the City Commission. If for any reason you don't receive these services, please call the Waste Collection Division.

Waste Collection & Disposal Division
Department of Public Works & Utilities
Telephone CEdar 2-2831

FLINT-GENESEE COUNTY

SOLID WASTE DISPOSAL STUDY AND INVESTIGATION

Local Governmental Unit

Questionnaire

Date________________________

1. Name of governmental unit. ______________________________

2. Name and address of person to contact for additional information, if other than addressee.

   ____

   ____

3. How do you presently dispose of solid waste?*

   ______ Private hauler (send copy of contract).

   ______ Pick-up service by municipality.

   ______ Individual hauls his own.

   ______ Combination of above. Describe: ______________________________

   ____

   ____

4. Where is solid waste being disposed of at the present time? ________

   ____

5. How is solid waste disposal being paid for at the present time? ____

   ____

* Solid Waste is defined as the discarded materials from residential, commercial, and industrial establishments, consisting of garbage, trash, rubbish, street refuse, ashes, and those wastes, both liquid and solid, generated by industrial processes that have no salvage value, cannot be disposed of to existing sewer systems, and may be both toxic and volatile.

6. How much does solid waste disposal cost? (Please specify in terms of dollars per ton, dollars per week, etc.)

Individual ____________

Governmental unit ____________

7. Estimate the amount of solid waste generated in your governmental unit.

Tons per week ____________

Yards per week ____________

8. Are there any businesses or industries that create large volumes or unusual types of solid wastes? ______ If so, please identify the business or industry and describe the type and volume of solid waste.

____

____

____

(attach additional sheets if necessary)

9. Indicate below any remarks or comments you may have regarding solid waste in your governmental unit.

____

____

____

____

____

____

____

____

Thank you for your cooperation.

PLEASE FILL OUT AND RETURN TO:

Genesee County Metropolitan Planning Commission
930 Beach Street
Flint, Michigan 48502

Solid Waste Disposal

Act 87 of the Public Acts of 1965 and Regulations

MICHIGAN DEPARTMENT OF PUBLIC HEALTH

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ACT 87
OF THE PUBLIC ACTS OF 1965

AN ACT to license and regulate garbage and refuse disposal; and to provide a penalty for violation of this act.

The People of the State of Michigan enact:

Sec. 1. As used in this act:

(a) "Refuse" means putrescible and nonputrescible solid wastes, except body wastes, and includes garbage, rubbish, ashes, incinerator ash, incinerator residue, street cleanings and solid market and industrial wastes.

(b) "Garbage" means rejected food wastes including waste accumulation of animal, fruit or vegetable matter used or intended for food or that attend the preparation, use, cooking, dealing in or storing of meat, fish, fowl, fruit or vegetable.

(c) "Rubbish" means nonputrescible solid wastes, excluding ashes, consisting of both combustible and noncombustible wastes, such as paper, cardboard, tin cans, yard clippings, wood, glass, bedding, crockery, or litter of any kind that will be a detriment to the public health and safety.

(d) "Ashes" means the residue from the burning of wood, coal, coke or other combustible materials.

(e) "Commissioner" means the state health commissioner.

(f) "Health officer" means a full time administrative officer of an approved city, county or district department of health.

(g) Applicant means individuals, firms, corporations or any political subdivisions of the state including any governmental authority created by statute.

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Sec. 2. No person shall dispose of any refuse at any place except a disposal area licensed as provided in this act. Nothing in this act nor any act of the commissioner's shall usurp the legal right of a local governing body from developing and enforcing local ordinances, codes, or rules and regulations on solid waste disposal equal to or more stringent than the provisions of this act, nor will this act relieve the applicant for license to operate a disposal area from obtaining a license from a local governing body when required or relieve the person owning or operating a disposal area from responsibility for securing proper zoning permits or complying with all applicable local ordinances, codes, or rules and regulations not in conflict with this act.

Sec. 3. (1) A person, partnership, corporation, governmental unit or agency thereof desiring a license to operate a disposal area shall make application therefor each year to the commissioner through the health officer on a form provided by the commissioner. Where the disposal area is located in a county or city not having a full time organized local health department, the application shall be made directly to the commissioner.

(2) The application shall contain the name and residence of the applicant, the location of the proposed disposal area, and such other information as may be necessary. The application shall be accompanied by a fee of $25.00, except that governments and agencies thereof are exempt from payment of the fee.

(3) Fees collected by the health officer shall be deposited with the city or county treasurer, who shall keep the deposits in a special fund designated for use in carrying out the purposes of this act. If there is an ordinance or regulation prohibiting a city board of health or health officer from maintaining any such special fund, the fees shall be deposited and used in accordance with the ordinance and regulations. Fees collected by the commissioner shall be deposited in the state treasury to the credit of the general fund.

Sec. 4. (1) Upon receipt of the application the commissioner or health officer or their representatives shall inspect the proposed site and determine if the proposed operation complies with this act and the rules and regulations adopted pursuant thereto.

(2) If the inspection discloses that the disposal area and the proposed operation thereof comply with this act and the rules and regulations adopted hereunder, and the commissioner or health officer finds that the applicant is a responsible and suitable person to conduct the business, the commissioner shall issue a license to the applicant upon filing by the applicant with the commissioner a performance bond in an amount equal to $500.00 per acre of disposal area, but not less than $2,500.00.

(3) Licenses shall expire on September 1 following the date of issuance but may be renewed upon payment of an annual fee of $25.00 if the licensee has complied with the act and the rules and regulations adopted hereunder.

Sec. 5. The commissioner may revoke a license, after reasonable notice and hearing if he finds that the disposal area is not operated in accordance with this act and the rules and regulations adopted hereunder.

Sec. 6. The commissioner shall promulgate rules and regulations which shall contain sanitary standards for disposal areas and otherwise implement this act. The rules shall be promulgated in accordance with the provisions of Act No. 88 of the Public Acts of 1943, as amended, being sections 24.71 to 24.80 of the Compiled Laws of 1948, and subject to Act No. 197 of the Public Acts of 1952, as amended, being sections 24.101 to 24.110 of the Compiled Laws of 1948. The commissioner or health officer shall periodically inspect all licensed disposal areas and enforce this act.

Sec. 7. This act does not prohibit a person from disposing of refuse from his own household upon his own land as long as such disposal does not create a nuisance or hazard to health.

Sec. 8. Any person who violates any provisions of this act is guilty of a misdemeanor. Each day of the violation shall be considered a separate violation.

This act is ordered to take immediate effect.

THIS ACT BECAME EFFECTIVE JUNE 28, 1965.

DEPARTMENT OF PUBLIC HEALTH
DIVISION OF ENGINEERING

Regulations Governing Solid Waste Disposal Areas

(Filed with Secretary of State, November 23, 1965)
Published in Supplement No. 45, 1954 Administrative Code

(By authority conferred on the Department of Public Health by section 6 of Act No. 87 of the Public Acts of 1965, being section 325.296 of the Compiled Laws of 1948, and by section 7 of Act No. 146 of the Public Acts of 1919, as amended, being section 325.7 of the Compiled Laws of 1948.)

R 325.1101. Definitions.

Rule 1. As used in these rules:

(a) "Cell" means compacted refuse completely enveloped by cover material.

(b) "Central garbage grinding" means the grinding by mechanical means of garbage accumulated by municipal, commercial or private delivery vehicles.

(c) "Director" means the director of the Department of Public Health.

(d) "Disposal area" means a site, location, tract of land, area, building, structure or premise used or intended to be used for partial and/or total refuse disposal.

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(e) "Ground water" means water in the ground that is in the zone of saturation.

(f) "Habitable building" means a structure or part thereof where persons live, sleep, reside or congregate.

(g) "Hazardous material" includes, but is not limited to, explosives, pathological wastes, radioactive materials and chemicals.

(h) "Health department" means an approved city, county or district health department, including the Michigan Department of Public Health.

(i) "Open dump" means a site where refuse is dumped and which due to lack of control may create a breeding place for flies and rats, may catch fire or may produce air pollution.

(j) "Premises" means a tract or parcel of land with or without habitable buildings.

(k) "Salvaging" means the controlled removal of reusable materials.

(l) "Sanitary landfill" means a method of disposing of refuse on land without creating nuisances or hazards to public health or safety, by utilizing principles of engineering to confine the refuse to the smallest practical area, to reduce it to the smallest practical volume, and to cover it with a layer of suitable cover at the conclusion of each day's operation or at more frequent intervals as necessary.

(m) "Scavenging" means the uncontrolled picking of materials.

(n) "Surface water" means a body of water whose top surface is exposed to the atmosphere including a flowing body as well as a pond and a lake.

R 325.1102. General requirements for licensing.

Rule 2. Where refuse is removed from premises, to a location other than its point of origin, for disposal or where refuse is not removed from the premises but disposed at the point of origin in such quantities as to become of public health concern:

Plans and specifications.

(a) Refuse disposal facilities shall be designed in accordance with these rules by a registered professional engineer. Detailed plans, specifications, and necessary reports shall be submitted in triplicate to the health department having jurisdiction for review, approval and file. Alterations or deviations from these plans shall also be submitted for approval and file. In the development of the required plans and specifications for sanitary landfill, hog feeding and open dump operations when the health department, in their judgment, believe that technical problems will not be encountered, the services of a registered professional engineer may be waived.

Inspection and evaluation.

(b) The director or health department having jurisdiction shall make routine inspections and evaluations of solid waste disposal operations. A written notice of deficiencies, together with recommendations for their correction, shall be provided to the operator or the appropriate individual, firm, corporation, governmental unit or agency thereof responsible for the solid waste disposal operation.

R 325.1103. Sanitary landfills; design.

Maps.

Rule 3. (1) The design of the sanitary landfill shall include 1 or more topographic maps at a scale of not over 100 feet to the inch with contour intervals which clearly show the character of land. These maps and accompanying data shall indicate the following: the proposed fill area; any borrow area; access roads; on-site roads; grades for proper drainage of each lift required and a typical cross-section of a lift; special drainage devices if necessary; fencing; structures on the site; existing and proposed utilities; and all other pertinent information to indicate clearly the soil characteristics, water table, orderly development, operation and completion of the sanitary landfill. A sanitary survey and a land use plan of the adjacent areas may be required.

Geology.

(2) The geological characteristics of the site shall be determined by on-site testing or from earlier reliable survey data to indicate soil conditions, water tables and subsurface characteristics.

Characteristics of cover material.

(3) Cover material shall be of such character that it can be com-

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pacted to provide a tight seal and shall be free of putrescible materials and large objects.

Water pollution and nuisance control.

(4) Sanitary landfill operations shall be so designed and operated that conditions of unlawful pollution will not be created and injury to ground and surface waters avoided which might interfere with legitimate water uses. Water-filled areas not directly connected to natural lakes, rivers or streams may be filled with specific inert material not detrimental to legitimate water uses and which will not create a nuisance or hazard to health. Special approval of the inert material to be used in this manner is required in writing from the health department having jurisdiction. Such approval shall be filed with the Director. Inert material shall not include residue from refuse incinerators, unless evidence, satisfactory to the Director, is submitted by the licensee substantiating that such residue will not create a nuisance or hazard to health.

Equipment.

(5) Adequate numbers, types and sizes of properly maintained equipment shall be used in operating the landfill in accordance with good engineering practice and with these rules. Emergency equipment shall be available on the site or suitable arrangements made for such equipment from other sources during equipment breakdown or during peak loads.

R 325.1104. Sanitary landfills; preparation of the site.

On-site roads.

Rule 4. (1) On-site roads shall be designed and constructed so that traffic will flow smoothly and will not be interrupted by ordinary inclement weather.

Fire protection.

(2) Suitable measures shall be available to extinguish accidental fires.

R 325.1105. Sanitary landfills; operations.

Supervision of operation.

Rule 5. (1) A landfill operation shall be under the direction of a responsible individual at all times.

Limited access.

(2) Access to a sanitary landfill shall be limited to those times when an attendant is on duty and only to those authorized to use the site for the disposal of refuse, except as otherwise approved in writing by the health department having jurisdiction and concurred in by the director. Access to the site shall be controlled by a suitable barrier.

Unloading of refuse.

(3) Unloading of refuse shall be continuously supervised, except as may be modified by Rule 5, paragraph (2).

Site maintenance.

(4) Measures shall be provided to control dust and blowing paper. The entire area shall be kept clean and orderly.

Spreading and compacting of refuse.

(5) Refuse shall be spread so that it can be compacted in layers not exceeding a depth of 2 ft. of compacted material. Large and bulky items, when not excluded from the site, shall be disposed of in a manner approved by the health department.

Volumes of cells.

(6) Volumes of individual cells shall not exceed the daily quantity of wastes.

Daily cover.

(7) A compacted layer of at least 6 inches of suitable cover material shall be placed on all exposed refuse by the end of each working day. The placing of cover material may be modified in writing by the health department having jurisdiction when deemed necessary.

Final cover.

(8) A layer of suitable cover material compacted to a minimum thickness of 2 feet shall be placed over the entire surface of each portion of the final lift not later than 1 week following the placement of refuse within that portion.

Maintenance of cover.

(9) All daily cover depths must be continually maintained and final cover depths shall be maintained for a period of 2 years.

Hazardous materials, including liquids and sewage.

(10) Hazardous materials, including liquids and sewage, shall not be disposed of in a sanitary landfill unless special provisions are made for such disposal through the health department having jurisdiction. This provision in no way precludes the right of a landfill operator to exclude any materials as a part of his operational standards.

Burning.

(11) No garbage or refuse containing garbage shall be burned at a sanitary landfill. Burning of select materials shall be severely restricted and shall be conducted only in designated areas with the permission of the health department having jurisdiction and other appropriate authorities.

Salvage.

(12) Salvaging, if permitted, shall be organized so that it will not interfere with prompt sanitary disposal of refuse or create unsightliness or health hazards. This provision in no way precludes the right of a landfill operator to prevent salvaging as a part of his operational standards. Scavenging shall not be permitted.

Insect and rodent control.

(13) Conditions unfavorable for the production of insects and rodents shall be maintained by carrying out routine landfill operations promptly in a systematic manner. Supplemental insect and rodent control measures

shall be instituted whenever necessary.

Drainage of surface water.

(14) The entire site, including the fill surface, shall be graded and provided with drainage facilities to minimize runoff onto and into the fill, to prevent erosion or washing of the fill, to drain off rainwater falling on the fill, and to prevent the collection of standing water.

Completion of landfill.

(15) An inspection of the entire site shall be made by the health department having jurisdiction to determine compliance with approved plans and specifications before the earth-moving equipment is removed from the site. Any necessary corrective work shall be performed before the landfill project is accepted as completed. Arrangements shall be made for the repair of all cracked, eroded, and uneven areas in the final cover during the first 2 years following completion of the fill.

Modification of sanitary landfill rules.

(16) Modifications of the rules on sanitary landfills as applicable to existing disposal areas may be made by the health department having jurisdiction. These modifications may continue in effect to May 31, 1968 providing the modifications are: approved in writing, supported by a comprehensive improvement plan, the modified operations are not a hazard to public health nor contribute to a nuisance and are concurred in by the director.

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R 325.1106. Open dumps.

Rule 6. Open dumps shall not be permitted unless the location and specific method of operation has been approved in writing by the health department and concurred in by the director, and provided further that the isolation and operation and maintenance does not constitute a nuisance or hazard to health.

R 325.1107. Hog feeding.

Feeding area.

Rule 7. (1) Garbage, as defined in Act 87 Public Acts of 1965, when fed to hogs shall be fed on a readily cleanable impervious feeding area.

General area.

(2) The general area including cooking facilities, when provided, shall be kept in a sanitary manner to prevent the attraction, harborage and breeding of insects and rodents and shall not create a nuisance.

Residue disposal.

(3) All residues resulting from the day's feeding operation shall be disposed of by a method approved by the health department having jurisdiction.

Garbage cooking.

(4) Garbage cooking operations licensed under Act No. 173 Public Acts of 1953 are exempt from the license provision of Act No. 87 Public Acts of 1965 but shall comply with all other applicable sections and these rules.

R 325.1108. Central garbage grinding.

Rule 8. Central garbage grinders receiving wastes categorized under introductory paragraph of Rule 2 shall be designed to provide reasonable safety for employees and to incorporate operating features which will assist in maintaining and operating the facility in a sanitary manner. The general sanitation in and around the central garbage grinder as well as the operational procedures employed shall be subject to the approval of the health department.

R 325.1109. Refuse burners.

Rule 9. Refuse burners receiving wastes categorized under introductory paragraph of Rule 2 shall be designed: to provide reasonable safety for employees, to incorporate operating features which will assist in maintaining and operating the facility in a sanitary manner and in accordance with Act No. 348 of the Public Acts of 1965 (the air pollution control act) and applicable local requirements. The general sanitation in and around the refuse burner as well as the operational procedures employed shall be subject to the approval of the health department.

R 325.1110. Other methods.

Rule 10. Any other method of solid waste disposal not covered by these rules shall be reviewed by the health department for the purposes of evaluating the design and operational methods with reference to: the nuisance factor, the safety of employees and the protection of the public health. Such disposal methods shall be subject to the evaluation and approval of the director.

OTHER SOLID WASTE DEMONSTRATION PROJECT REPORTS:

Project No.	Grantee	Report
D01-UI-00004	City of Madison, Wisconsin	Solid waste reduction/salvage plant; an interim report, City of Madison pilot plant demonstration project. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. 25 p.
D01-UI-00018	City of Santa Clara, California	Solid wastes landfill stabilization; an interim report. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. 146 p.
D01-UI-00026	Quad-City Solid Wastes Committee Paterson, New Jersey	Quad-City solid wastes project; an interim report, June 1, 1966 to May 31, 1967. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. 192 p.
D01-UI-00038	District of Columbia *Final Report: Phase 1*	Special studies for incinerators; for the Government of the District of Columbia, Department of Sanitary Engineering. Public Health Service Publication No. 1748. Washington, U.S. Government Printing Office, 1968. 80 p.
D01-UI-00060	City of Des Moines, Iowa	Collection and disposal of solid waste for the Des Moines metropolitan area; a systems approach to the overall problem of solid waste management; an interim report. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. 326 p.
D01-UI-00073	American Public Works Association Research Foundation, Chicago, Illinois	The Tezuka refuse compression system; a preliminary report. Cincinnati, U.S. Department of Health, Education, and Welfare, 1969. 47 p.
D01-UI-00080	Metropolitan Sanitary District of Chicago	Land reclamation project; an interim report. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. 338 p.

Single copies of the above publications may be obtained by writing to: U.S. Department of Health, Education, and Welfare, Public Health Service, Consumer Protection and Environmental Health Service, Environmental Control Administration, Bureau of Solid Waste Management, 222 East Central Parkway, Cincinnati, Ohio 45202.